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

A Thesis

by

JAMES T. ANDERSON

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Approved as to style and content by:

Bart M. Ballard, Ph.D.
(Chairman of Committee)

Ralph L. Bingham, Ph.D.
(Member)

David G. Hewitt, Ph.D.
(Member)

Thomas E. Moorman, Ph.D.
(Member)

Alberto M. Olivares, Ph.D.
(Dean, College of Graduate Studies)

May 2008

ABSTRACT

Survival, Habitat Use, and Movements of Female Northern Pintails
Wintering Along the mid-Coast of Texas

(May 2008)

James T. Anderson, B.S., University of Arkansas
Chairman of Advisory Committee: Dr. Bart M. Ballard

The northern pintail (*Anas acuta*) has been a species of concern among the waterfowl community since the 1980s with several competing hypotheses potentially explaining their decline. Over-winter survival, habitat use, and movements of female pintails were investigated along the mid-coast of Texas during winters of 2002–03 and 2003–04. I captured and attached radiotransmitters to 315 (141 adults, 174 immatures) female pintails in October and November during 2002 and 2003 and relocated individuals twice every 5–10 days to assess status and habitat use. I recorded 117 mortalities during the study. Over-winter survival estimates ranged from 0.31 to 0.41 and are the lowest reported for female pintails. Immature females were 1.3 times more likely to die than adults. Rice agriculture and palustrine emergent wetlands were preferred by pintails wintering along the mid-coast of Texas. Additional palustrine emergent wetlands are needed to offset palustrine wetland and rice agriculture losses along the Texas mid-coast.

DEDICATION

This manuscript is dedicated to my grandfather, James T. Dial, for instilling in me the appreciation of God's Country, of the outdoors and of all things wild. We'll chase that 'Ol Big One again soon.

ACKNOWLEDGMENTS

Due to the mobility of radio-tagged female pintails and the extensive study area for the project along the central Texas Coast numerous people were involved, some directly and others indirectly, with the culmination of this manuscript. As Leopold championed, the importance of every “cog and wheel” was evident in all who put their heart and soul into making this research project a reality.

This project was funded by and was a collaborative effort between Caesar Kleberg Wildlife Research Institute (CKWRI), Ducks Unlimited, Inc. (DU), Gordon and Mary Cain Foundation, Gulf Coast Joint Venture, Rosewood Foundation, San Antonio Livestock Exposition, and the Texas Parks and Wildlife Department (TPWD). I would also like to acknowledge the staff at Northern Prairie Wildlife Research Center (NPWRC) for their contributions to this research.

For bringing me on initially as part of the redhead team, initiating the pintail research, assisting in fieldwork, harvest reports, and thesis editing, and sharing your passion for waterfowl and ecology, I thank my advisor Dr. Bart Ballard. I extend my gratitude to committee members Drs. Ralph Bingham and David Hewitt of CKWRI and Dr. Thomas Moorman of DU for your encouragement, comments, and suggestions.

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I thank David Lobpries of the TPWD for being my right-hand man for the project. I am indebted to David for sharing his 35+ years experience with the ecology and history of the Texas mid-coast and his intimate knowledge of waterfowl and the Texas Prairie Wetland Projects. I also thank his family for providing me a home away from home. For assisting with trapping and processing pintails and providing lodging and other supplies, I also thank Dr. Todd Merendino, Jesse Oetgen, Kevin Kriegel, and Matt Nelson of the TPWD. I thank Justin Hurst of TPWD for providing information on hunter harvests and Joe Goff of TPWD for information concerning potential trapping locations. I thank Corey Mason for surveying for pintails in the Livingston Lake area during spring migration. At Guadalupe Delta Wildlife Management Area, I thank Greg Sheguit and Leroy Reineke for their support and contributions in making the research a success. I thank pilot Dwayne Havis for outfitting the TPWD plane with telemetry equipment for tracking during mid-winter surveys. For production of the video *Texas Pintails* and capturing of numerous still images for presentations, I thank Lee Smith of TPWD for his patience and passion for filming wild things.

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For landowner connections, hunter harvest reports, and trapping location information, I thank Ed Ritter and Brandon Wieme of the Texas Field Office of DU. I also thank Tim Soderquist of DU for reports on harvested pintails. In addition, I thank Michael Brasher with the Gulf Coast Joint Venture for his assistance with my research and for providing data for the Texas mid-coast initiative area.

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I thank my pilot Anse Windham for stomaching long tracking excursions, even when I could not, for mastering aerial telemetry locations, and for being available to fly both day and night with little prior notice.

For contending with unconventional tracking shifts and sometimes unpredictable pintails, and whose tracking was the backbone of the research, I thank the crew of technicians: Johnathan Dodd, Sara Garreau, Dusty Lowe, Shaun Oldenburger, and Candace Steimer.

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Lastly, I am especially grateful to the strength sustained to me by my family. Especially my wife, Jennifer, for her understanding and unwavering support while enduring extended field seasons while I was away and for entertaining our lab, Kota, and our Boykin, Annabelle, while they missed out on waterfowling opportunities. I also look forward to enjoying many days in the outdoors with our new daughter, Ella Grace.

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CHAPTER I

SURVIVAL OF FEMALE NORTHERN PINTAILS

WINTERING ALONG THE MID-COAST OF TEXAS

Northern pintails (*Anas acuta*; hereafter, pintails) are widely distributed in North America and are the most abundant dabbling duck breeding in the Nearctic, with the majority of the birds in North America settling in the Prairie Pothole Region of the northern Great Plains of Canada and the United States (Austin and Miller 1995, Bellrose 1980). The largest wintering concentrations of pintails occur in the Central Valley of California, the coasts of Mexico, and coastal Louisiana and Texas (Bellrose 1980). Wintering pintails arrive along the Gulf Coast in September and are most abundant during late November–January, with some individuals remaining through April (Bellrose 1980, Austin and Miller 1995, Wilson and Esslinger 2002).

Like most prairie nesting duck species, pintails reached low populations during the late 1980’s to early 1990’s, presumably as a result of extended drought throughout much of their breeding range. From 1993–1999, improved wetland conditions in the U.S. and Canadian Prairies resulted in most duck species reaching population levels well above long-term averages (Wilkins and Otto 2002). However, pintail populations did not respond to the excellent habitat conditions despite populations appearing to closely track wetland conditions historically (Smith 1970, Miller and Duncan 1999). In 2002, the continental pintail population reached an all-time low of approximately 1.79 million birds, which was 58% below the long-term average (1955–2002; Wilkins and Otto 2002). The population increased slightly to an estimated 2.18 million birds in

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This thesis follows the style of the Journal of Wildlife Management

2004 (United States Fish and Wildlife Service 2004), with current estimates at 3.34 million birds (18% below the 1955–2005 average; United States Fish and Wildlife Service 2007). However, the North American population remains considerably below the North American Waterfowl Management Plan (NAWMP) goal of 5.6 million birds (United States Fish and Wildlife Service and Canadian Wildlife Service 1986). Pintail populations exhibit a long-term decline (1970–2003; NAWMP Plan Committee 2004), causing managers to designate the pintail as a species of continental concern.

The concern over pintail populations continues as they fail to recover from levels much lower than long-term averages. Declining pintail harvests in the Central Flyway are of major concern to waterfowl hunters and managers. Bag limits have been reduced [e.g., from daily bag limits of 10 pintails per hunter in the 1970s (Point System) to the current format under the Hunter's Choice Program (up to 1 pintail/day per hunter depending on species composition of daily bag)] and conditions for hunting season closure have been investigated. In Texas, the 2002–04 pintail seasons were curtailed to 39 days each season, with a 1 bird daily bag per hunter. Recommendations for pintail research were outlined with emphasis placed on recruitment components of the pintail life cycle (Cox et al. 2000). The evaluation of habitat management on migrating and wintering areas was given less priority (Cox et al. 2000). Additional hypotheses have been developed to explain continued low population levels, including poor nest success, decreased nesting propensity, disease, decreased adult survival, inadequate duckling survival, relatively high harvest, and low non-breeding period survival (Northern Pintail Workshop 2003).

Over the past 3 decades researchers have placed more emphasis on wintering waterfowl ecology and management (Reinecke 1981, Weller 1988, Smith et al. 1989). Wintering waterfowl experience several energy demanding events such as molt, pair formation, and storage of energy reserves for migration (Hepp and Hair 1983, Gammonley and Heitmeyer 1990, Smith and Sheeley 1993). Wintering waterfowl are also subject to important sources of mortality including harvest-related mortalities, avian and mammalian predation, disease, and exposure to toxins (Cain and Feierabend 1988, Stutzenbaker 1988, Cox et al. 1998, Esler et al. 2000). Additionally, human disturbances such as land use changes threaten winter habitat for pintails, potentially making it more difficult for pintails to meet their energy demands (Cain 1988, Austin and Miller 1995, Ballard et al. 2004).

The Texas Coast is one of the most important wintering areas for waterfowl in North America (Bellrose 1980, Stutzenbaker and Weller 1989) and is the most important wintering area for waterfowl in the Central Flyway (Howard and Kantrud 1986, Haukos 2003), wintering $\leq$78% of flyway pintails (Texas Parks and Wildlife Department, unpublished data). However, wintering duck habitat along the Texas Coast has declined over the past 5 decades, particularly habitats important to pintails (Moulton et al. 1997, Wilson and Esslinger 2002).

Westward expansion of the Houston metropolitan area into the Katy Prairie (Hobaugh et al. 1989) and associated wetland losses (Tiner 1984, Moulton et al. 1997), subsidence and faulting due to natural resource extraction (Wilson and Esslinger 2002), and salinity modification (Gosselink 1984) are of special concern along the Texas Coast. Increased human activity and development conflict directly with waterfowl wintering along the Texas coast (Stutzenbaker and Weller 1989), and may displace some pintails wintering in this region. The Texas Coastal Zone supports one-third of the human population and economic wealth, while having only 6% of the total state land mass

(Stutzenbaker and Weller 1989). Finally, the effects of future conflicts over water, water use patterns and trends, and climate change during the 21st century will have repercussions on wetland and water availability in Texas that may impact waterfowl habitat or populations (Norwine et al. 2005).

Continuing wetland losses due to anthropogenic disturbances have increased the need to conserve habitats important to pintails (Dahl and Johnson 1991). Coastal wetland loss in Texas was estimated at 1,432 hectares per year between the mid-1950's and the early 1990's (Moulton et al. 1997). Recent large-scale conversion of rice agriculture to cotton and soybeans in the Rice Prairie Region (RP) of Texas is cause for concern among waterfowl managers. Acreage planted in rice in Texas has declined by 60% over the last 3 decades, with 34% (52,120 hectares) occurring between 1988 and 1998 (Esslinger and Wilson 2001). Further declines are anticipated because of several problems being experienced by 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). Compounding the decline of rice habitat has been a loss of over 100,000 hectares of non-farmed freshwater wetlands throughout the Coastal Plain of Texas, most of which were high-quality palustrine wetlands (Moulton et al. 1997).

As wintering waterfowl habitat along the Texas Coast continues to decrease, it is unknown whether pintails will shift to alternative habitats within this region or whether they will make temporary or permanent movements to other regions (e.g., southwestern Louisiana, Mississippi Alluvial Valley). Because pintails exhibit high winter site fidelity, particularly in coastal areas (Hestbeck 1993*a*), it is possible that many will move to estuaries along the Texas Coast as freshwater habitats adjacent to the coast are reduced in their capacity to maintain large concentrations of wintering waterfowl. Saline environments typically provide less diet diversity (Serie and Swanson 1976, Euliss et al. 1991) and less food availability (Tietje and Teer 1996) for dabbling ducks (*Anas* spp.) than freshwater wetlands. Further, recent research on pintails wintering on the lower-coast of Texas (Ballard et al. 2004) found diet quality to be lower than published accounts of pintail diets in freshwater environments, resulting in pintails leaving southern Texas wintering areas much leaner than those wintering in freshwater habitats in other regions [pintails wintering in the Laguna Madre lost approximately 20% of their body mass over winter (Ballard et al. 2006)].

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 radiotransmitters and radio telemetry suggest there is considerable variation in regional overwinter survival of pintails throughout North America. For instance, pintails in Louisiana (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 rates. 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 and Haukos 2006) 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). In contrast, survival rates of mallards 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 is warranted for coastal Texas where the majority of pintails in the Central Flyway winters annually. Such information is needed to develop or refine habitat and management strategies.

I conducted research to examine survival rates of female pintails during winter along the mid-coast of Texas to:

(1) Estimate rates of survival of adult and juvenile female pintails.

This study was designed to test the following research hypotheses:

H_1: Survival of female pintails is dependent on habitat conditions, age, and region.

Prediction 1: Female pintails will exhibit higher overwinter survival rates during wet winters than drier winters.

Prediction 2: Immature female pintails will exhibit lower survival rates than adults because of presumed greater vulnerability to harvest.

Prediction 3: Harvest rates will be lower for female pintails wintering in coastal habitats compared to rice field habitats because of lower hunting intensity.

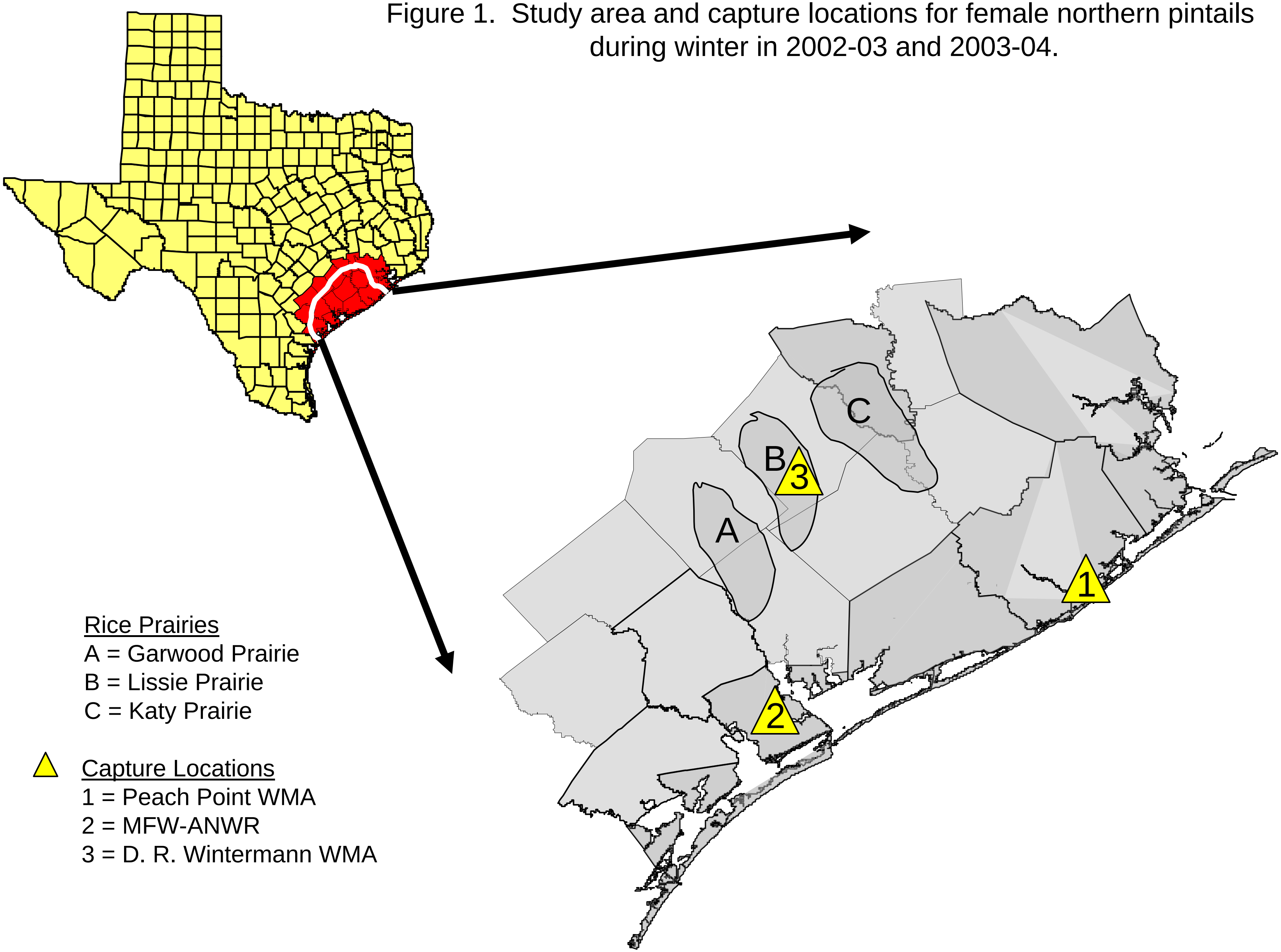
STUDY AREA

Historically, the coastal prairie of Texas was a tall grass plant community interspersed with bands of woodlands along streams and bayous that contained natural depressional wetlands that were wet during winter and 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% of the national total (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.

My study was conducted throughout the Gulf Coast and Rice Prairie Regions of the Texas mid-coast. My research focused on the Gulf Coast Joint Venture (GCJV) Texas Mid-Coast Initiative area (Figure 1), 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 a variety of wetland habitats (Stutzenbaker and Weller 1989), of which 3 major waterfowl habitats are available: (1) agricultural lands [e.g., rice rotation, pasture, crawfish (*Procambarus clarkii*) production] (2) coastal marsh (e.g., salt, brackish, intermediate, and fresh marshes) and (3) seagrass beds (Wilson and Esslinger 2002).

The rice prairies are found along the southeastern Texas coast, comprising 4 major prairies as well as 6 smaller, adjacent prairies that encompass approximately 900,000 hectares in portions of 18 counties (Hobaugh

Figure 1. Study area and capture locations for female northern pintails during winter in 2002-03 and 2003-04.



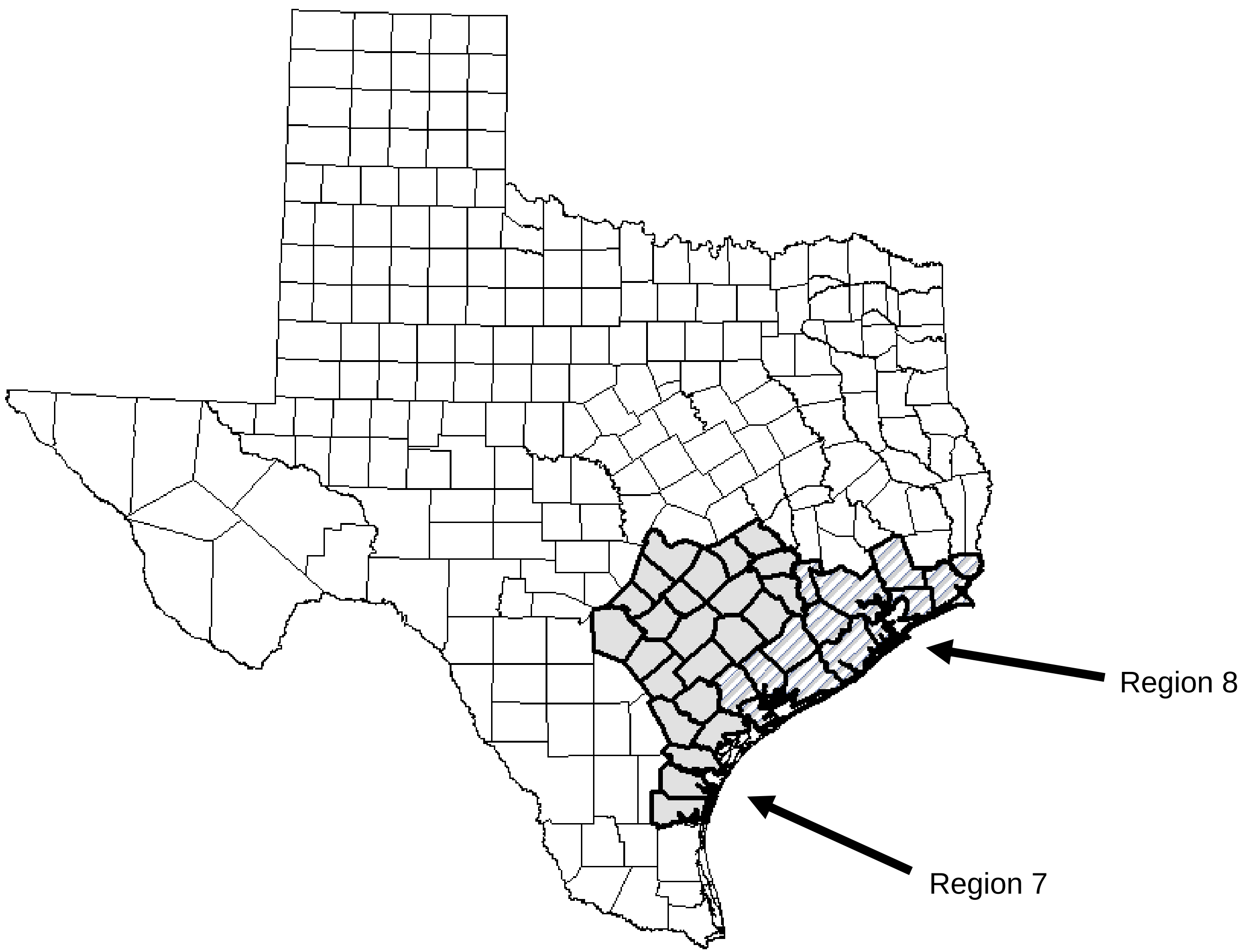
et al. 1989). The major rice prairies of Texas are the Beaumont, Katy, Lissie, and Garwood prairies, collectively referred to as the Gulf Coast Prairie vegetational region (Gould 1975). The Katy, Lissie, and Garwood prairies occur in the mid-coast and along with coastal marsh and freshwater wetlands comprise the most important waterfowl habitats in this region (Hobaugh et al. 1989, Stutzenbaker and Weller 1989) (Figure 1).

The climate of the Texas mid-coast 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 ranges 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 (ranging from 7–20° C), with the lowest readings occurring from December through February (NOAA 2007). Occasional tropical storms and hurricanes along the Texas coast can lead to highly variable precipitation patterns and wetland conditions (NOAA 2007).

Climatological data

Habitat conditions were similar during winters 2002 and 2003, with year 1 being moderately wetter than year 2. The Palmer Drought Severity Index (PDSI) (by division; study area contained within both divisions 7 and 8); (Figure 2) indicated near normal (division 7; -1.9 to +1.9) to unusually moist (division 8; +2.0 to +2.9) conditions prior to trapping on 19 October 2002, wet conditions [very moist (+3.0 to +3.9) to extremely moist (+4.0 and above) for both divisions] throughout winter, and near normal throughout by 3 May 2003 (http://www.cpc.ncep.noaa.gov, http://www.drought.noaa.gov/index.html). The PDSI suggest a steady drying trend throughout late winter into early spring

Figure 2. Palmer Drought Index Regions 7 and 8 for Texas.



2002–03. In 2003, conditions from 18 October–31 January were near normal for both divisions, with division 8 having an unusually moist spell from 14–28 February and then returning to near normal conditions throughout the remainder of the study (24 April 2004) (http://www.cpc.ncep.noaa.gov). Overall, the PDSI indicated moderately wet conditions during 2002–03 and near normal conditions for winter-spring 2003–04. However, habitat availability from February–April 2004 declined rapidly as the Rice Prairie (RP) region dried due to high evapotranspiration rates and an apparent large-scale release of water at the end of the waterfowl season.

Precipitation in coastal Texas is highly variable and tropical weather can greatly increase amounts, effecting habitat conditions for waterfowl. Hurricane Claudette, a category 1 hurricane, made landfall in Calhoun County on the coast of Matagorda Island, near Port ‘O Connor, on 15 July 2003, and may have altered some wetlands important to pintails near the coast and on barrier islands as surge was reported up to 2–3 m above normal tide levels along the mid-coast (http://www.srh.noaa.gov). In addition, tropical storm Fay struck the same area a year earlier near the southern Matagorda Peninsula, 16 km east of Port ‘O Connor, on 7 September 2002 with little rainfall, but deposited over 33 cm of rainfall in parts of Brazoria County (http://www.srh.noaa.gov). Tropical storm Fay may have enhanced wetland habitat prior to the onset of trapping in 2002.

METHODS

Capture

Pintails were captured along the Texas mid-coast from 21 October–21 November 2002 and 10–30 November 2003 with rocket nets and swim-in traps baited with rice. Trapping effort was delayed until late October–November due to concerns of potentially tagging stopover migrants en route to more southern areas (e.g., lower Texas coast and east coast of Mexico) (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 Fish and Wildlife Service banding permit #21314–K); the 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 spring 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), and (4) middle toe length. Flattened wing chord length was measured using a graduated ruler (1 mm). Birds were allowed to dry prior to weighing. To account for ingesta, esophageal contents were scored (0-4) based on the amount of rice in the bird's esophagus, similar to techniques used by Cox and Afton (1998). One person made all structural measurements and scored esophageal contents to provide consistency in measurements.

Female pintails were fitted with a harness-type, 21-g VHF radiotransmitter (Dwyer 1972), each with a unique frequency (165–167.999 MHz) and theoretical operating life of 200–225 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). All final adjustments of radiotransmitters were conducted by B. E. Davis, United States Geological Survey, for consistency. Transmitters were not used for females that weighed less than 600 g at capture (3.5% of body weight). Otherwise, all healthy females were selected at random and were assigned transmitters randomly. Female pintails were banded using standard U.S. Fish and Wildlife Service size 6 aluminum leg bands.

All radiotransmitters had mercury-type mortality sensors that caused the pulse rate to double (120 bpm) if transmitters were motionless for $\geq$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 (Cox 1996). 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 (i.e., date and location bird was harvested).

Instrumented females were provided rice (*Oryza sativa*) and water *ad libitum* while being held. Pintails were spaced evenly throughout holding pens (poultry crates) to minimize stress during processing. Instrumented females were released at their capture sites $\leq$24 h following capture, with flight status recorded upon release (scored as poor, moderate, or good) (Cox and Afton 1998). Captured male pintails were held (as space for captured individuals permitted) with females to reduce the probability of breaking pair bonds. Males and females not receiving transmitters were processed, banded, and released with instrumented females.

Telemetry and Monitoring

Flights to monitor status (alive or dead) and location of female pintails were conducted at 7–10 day intervals during 2002–03 and 5 day intervals during 2003–04 each day/night that weather permitted. Fixed-wing aircraft outfitted with 4-element null-peak telemetry antennas was used to search the entire study area (Gilmer et al. 1981). I attempted to divide sampling effort to monitor habitat use equally between diurnal and nocturnal periods, obtaining a diurnal and a nocturnal location (every 7–10 day interval during 2002–03 and every 5 day interval during 2003–04) per marked individual. Flights were periodically made along the upper and lower Texas coasts to search for missing individuals.

Radiotransmitters detected in mortality mode were investigated immediately. Aerial locations were communicated to technicians in trucks equipped with 4-element null-peak telemetry antennas for accurate estimation of locations using triangulation (Chapter 2) to locate mortalities. 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 for position was made using Global Positioning System (GPS) receivers (Garmin Etrex Venture, Garmin International, Inc., Olathe, Kansas).

Locations of mortalities were recorded using GPS receivers on the ground or from fixed-wing aircraft using a Garmin35 GPS (Garmin International, Inc., Olathe, Kansas) and a Compaq Pocket PC with Anywhere Map software when ground access was not possible.

Causes of mortality were investigated and determined if sufficient evidence existed based on location and characteristics of the carcass. Hunting guides and landowners were interviewed following direct evidence of hunting activity (e.g., stretched harness, spent cartridges, hunter tracks, etc.) when hunter harvest or crippling was suspected. Avian and mammalian predation was determined by direct investigation of carcasses and on-site evidence (e.g., condition of carcass, avian roosting site, tracks, etc.). Hunter harvest reports were recorded throughout the waterfowl season as hunters relayed harvest information to researchers.

Waterfowl Seasons

Hunting season for pintails were the last 39 days of the 2002–03 and 2003–04 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 2002–03, and 25–26 October and 8 November–18 January during 2003–04.

Statistical Design

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). When the exact date of death was unknown, it was estimated using the midpoint between the last date alive and the first detection of a mortality signal (Mayfield 1961) using Program MARK (White and Burnham 1999).

Female pintail survival during late fall and winter was estimated using nest success modeling in Program MARK. Females were censored following the last date they were determined alive in the study area. I excluded from analysis females that died or departed the study area in the first 72 hours of exposure and never returned. Survival estimations were initiated 72 hours following release because instrumented pintails are subject to radio effects and appear to be more susceptible to depredation during the first few days following release (Cox and Afton 1998). Parameter estimates were model averaged across the entire parameter set and AIC (Akaike Information Criteria) model selection was used to make inferences among competing models.

The effects of several factors were tested that may explain variation in winter survival of the sample of radio-marked pintails. A body condition index was estimated for each individual at capture and was considered to be a factor that may be related to an individual's ability to survive during winter. This included body mass of captured females corrected for structural size. HY females were assumed to be more vulnerable to predation and harvest than adults. Year was considered a possible source of variability given potential differences in habitat conditions, weather, hunting pressure, and predator abundances between years. Because harvest-related mortality accounts for a large portion of pintail mortalities in other regions, hunting season also was included in the model. This included both the regular duck season and the pintail hunting season, that occurred during the last 39 days of the regular duck season of both years. Three different types of temporal trends were modeled: (1) no trend [the dot model], (2) a linear trend [the T model], and (3) a quadratic trend [the TT model]. Using Program MARK, I ran an exploratory set of 20 models for the dataset with 5 factors combined in an additive or multiplicative manner. Daily survival rate was estimated over a 183-day wintering period.

I also used Kaplan-Meier survival functions to obtain product limit estimates of survival curves for the 2 age groups (HY and AHY). This was accomplished using the SAS (SAS Institute, Cary, North Carolina) procedure PHREG with no covariates, using an option for late entry (left truncation), and a STRATA statement for age group (SAS 1999). The resulting 2 estimated survival functions were tested to see if they could have come from the same underlying true survival curve using a partial likelihood score chi-square test obtained with the SAS procedure PHREG with a single dichotomous covariate (age group) using an option for late entry. Ninety-five percent confidence intervals were obtained for each survival curve using the formulas of Pollock et al. (1989).

RESULTS

Capture

I captured and attached radiotransmitters to a total of 315 (141 adults, 174 immatures) female pintails in 2002 and 2003 (Appendix A). One-hundred fifty-seven female pintails were captured and radio-tagged in 2002 with baited rocket nets (146; 93%) and swim-in traps (11; 7%). In 2003, 158 female pintails were captured, of which 156 (99%) were captured with rocket nets and 2 (1%) with swim-in traps. The use of swim-in trapping was abandoned in 2003 after several problems with raccoons, similar to findings by Cox and Afton (1998). During 2002, 11 (7%) females were captured and instrumented at Peach Point Wildlife Management Area in Brazoria County, while in 2003, 67 (42%) of females were captured at D. R. Wintermann Wildlife Management Area in Wharton County (Figure 1). All other females were captured at the Myrtle-Foester-Whitmire unit (near Indianola) of the Aransas National Wildlife Refuge (MFW-ANWR) in Calhoun County (Figure 1).

Age ratios of radiotagged female pintails were 1HY:1AHY in 2002 and were 1.5HY:1AHY in 2003. Average capture date was 18 November in 2002 and 24 November in 2003. On average, females were 19–22 g heavier at capture in 2003 than in 2002 (Table 1). Female weights did not differ between the D. R. Wintermann Wildlife Management Area (rice prairie) (789 g) and the MFW-ANWR females (792 g) in 2003.

Mean holding time for processing birds was 19 hrs 29 min in 2002 and was 15 hrs 11 min in 2003. The longer holding time during 2002 was due to one large rocket-net capture on MFW-ANWR (approximately 700 total waterfowl captured; 139 females, 89% of yearly total, were fitted for transmitters).

Table 1. Live female northern pintail mass in grams (corrected for esophageal content), culmen length (mm), head length (mm), total tarsus (mm), middle-toe length (mm), and flattened wing chord (mm) measurements for female pintails captured in mid-coastal Texas during October–November 2002–03.

Year	(*n*)	Body mass		Culmen		Head length		Total tarsus		Middle-toe		Wing chord	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
2002	157	776	42.43	46.45	4.74	99.42	4.29	51.00	4.12	47.40	5.54	248	2.12
2003	158	791	30.80	46.44	0.11	99.45	0.91	50.21	1.21	46.36	0.99	246	0.71
2002–03	315	783	30.80	46.45	1.65	99.44	1.31	50.60	1.11	46.88	4.11	247	4.95

Cause-specific mortality

Although cause-specific mortality was not one of the objectives of this study, I recorded the fates of all known mortalities during both years. Because radiotagged pintails were being tracked in several counties in the mid-coast for habitat use and survival estimates, the large sample precluded monitoring any more frequently than twice every 5 days. The sampling interval combined with the lag time for the mortality sensor to activate (8 hours) allowed increased time for scavenging, resulting in unknown fates. In addition, some transmitters that were underwater emitted weak signals and took several attempts to recover. Also, acquiring access to private lands delayed recovery of some individuals.

I recorded 123 mortalities across the 2 years of the study. Of these, 45 (36%) were confirmed harvest-related, 5 (4%) were from avian depredation, 2 (2%) were from avian cholera (*Pasteurella multocida*), and 71 (58%) were suspected mammalian depredations or unknown fates.

2002–03 Mortalities. – Sixty-five mortalities were recorded during 2002–03. Twenty-four (37%) pintails had harvest related mortalities in 2002–03. Of these, 3 (13%) were harvested illegally, 13 (54%) were harvested legally, and 8 (33%) were due to crippling losses. I surmised the majority of harvested pintails were directly reported to investigators due to the fidelity of marked pintails to the study area and the low number of non-signal birds. Also, harvest was assumed if a shot bird was left intact after investigation by the hunter. Of the illegal harvests in 2002, all occurred during regular duck season prior to the opening of the restricted pintail season. One hunter reported the reward information (telephone) on a female shot south of Rockport in Aransas County on 1 December and was unaware that pintail season had not yet opened, one was harvested before the season and was reported to the Office of Migratory

Bird Management Bird Banding Laboratory well after the close of season (shot on 6 December near Katy in Harris County), and one presumably left the bird intact on 9 November less than 30 m from a duck blind in southern Wharton County. Six of the 13 legal harvests (46.2%) were shot in Calhoun County, 5 were harvested in the rice prairies (38.5%; 2 Colorado, 1 Fort Bend, 1 Matagorda, and 1 Wharton County), one (0.8%) 18 miles west of Raymondville in Willacy County (lower GC), and 1 did not report a location (0.8%). Harvest-related crippling loss was assessed on-site and from interviews with waterfowl guides, hunters, and landowners. Crippling loss was indicated if a carcass was inspected and found with shot.

The remaining 38 (58%) mortalities showed signs of mammalian depredation or scavenging. The scavenger community is extremely diverse along the Texas mid-coast (Stutzenbaker 1988) and creates uncertainty regarding true causes of these mortalities. Thus, I lumped all these as unknown fates to minimize speculation about the impacts caused by mammalian predators. Of the 65 recorded mortalities in 2002–03, I found 3 (5%) as a result of avian predations.

2003–04 Mortalities. – Fifty-eight mortalities were recorded during the 2003–04 field season. Known fates were attributed to avian predation (2; 3.5%), avian cholera (2; 3.5%), and harvest-related mortality (21; 36%). The remaining 33 (57%) were from mammalian predation or of unknown fate. Of the harvest-related mortalities, 14% were harvested illegally, 48% due to legal harvest, and 38% were attributed to crippling losses. Of the illegal harvests, 2 were due to crippling losses on 1–2 December (1 Colorado, 1 Wharton County), while a hunter stomped the third in a mudflat in a drained agricultural impoundment in Wharton County on 30 November. All the illegal harvests occurred during regular duck season prior to the opening of pintail season, similar to 2002. Legally harvested pintails were shot in Colorado (3), Wharton (5), and Calhoun (1) Counties. The area was not reported for one bird. Crippling losses were recovered from Colorado (2), Wharton (5), and Lavaca (1) Counties. One of the 2 avian mortalities was found in a rice field in Calhoun County with the breast removed, while the other was located with other waterfowl carcasses near a San Bernard River drainage (Wharton County) adjacent to a rice field goose roost.

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

Two of the unknown fates were tracked to a bald eagle (*Haliaeetus leucocephalus*) nest in 2003 near Sandy Creek in Wharton County. The nest location was reported to Texas Parks and Wildlife Department and was confirmed to be active (B. Ortego, Texas Parks and Wildlife Department, personal communication). One of the mortalities was located from the air in a rice field, but was in the eagle nest the next day when researchers went to investigate. This finding suggests that the eagle had scavenged at least one of the pintails.

Survival

Of the 20 models ran with Program MARK, 7 models explained 91% of the variation in winter survival of female pintails wintering along the Texas Gulf Coast (Appendix B). Based on MARK output, there is evidence that age, year, and a quadratic time trend are important variables in winter survival of pintails along the Texas Gulf Coast. Corrected body mass at capture was unimportant to winter survival. When added to the best model, that model dropped 1.4 AIC units and the beta for body mass in the model overlapped zero. Similarly, hunting season, no time trend, and a linear time trend poorly explained variation in winter survival of pintails along the Texas Coast.

Weekly survival probabilities for 2002–03 exhibited a strong quadratic trend, gradually increasing during the first 6 weeks post-release and then increasing at a decreasing rate throughout winter. During the first year, overwinter survival was estimated to be 40.8% for AHY and 32.0% for HY females (Figure 3). Based on Program MARK output for the first year, age was determined to have an effect on female pintail survival during winter. During 2003–04, overwinter survival was estimated to be 39.6% for AHY and 30.9% for HY females (Figure 4). Similar to the first year, weekly survival probabilities during 2003–04 were best explained by a quadratic trend; however, survival probabilities increased at a more rapid rate during the first 6 weeks post-capture when compared to the first year. Weekly survival then increased at a decreasing rate through mid-February, and dropped from late February to April 2004 for both AHY and HY females (Figure 4).

Survival estimates using Kaplan-Meier survival functions corroborated my findings with Program MARK for HY females. Using the SAS procedure PHREG, I estimated survival to be 33.5% for HY females. However, the Kaplan-Meier survival estimate for AHY females (62.7%) was higher than estimates calculated using Program MARK.

Figure 3. Survival curves and 95% confidence intervals for adult (AHY) and hatch year (HY) female northern pintails radio-tagged and tracked in winter 2002-03 along the Texas mid-coast.

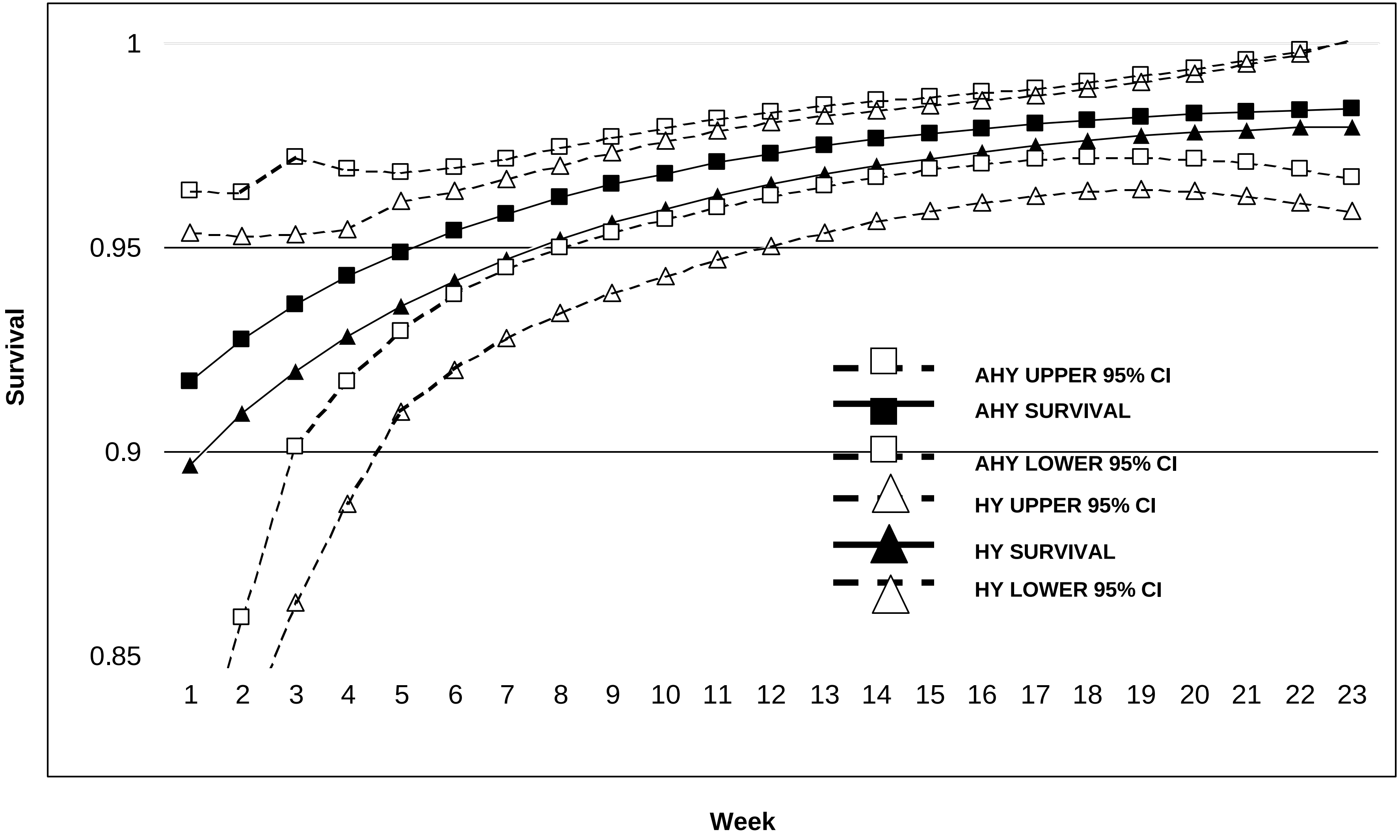
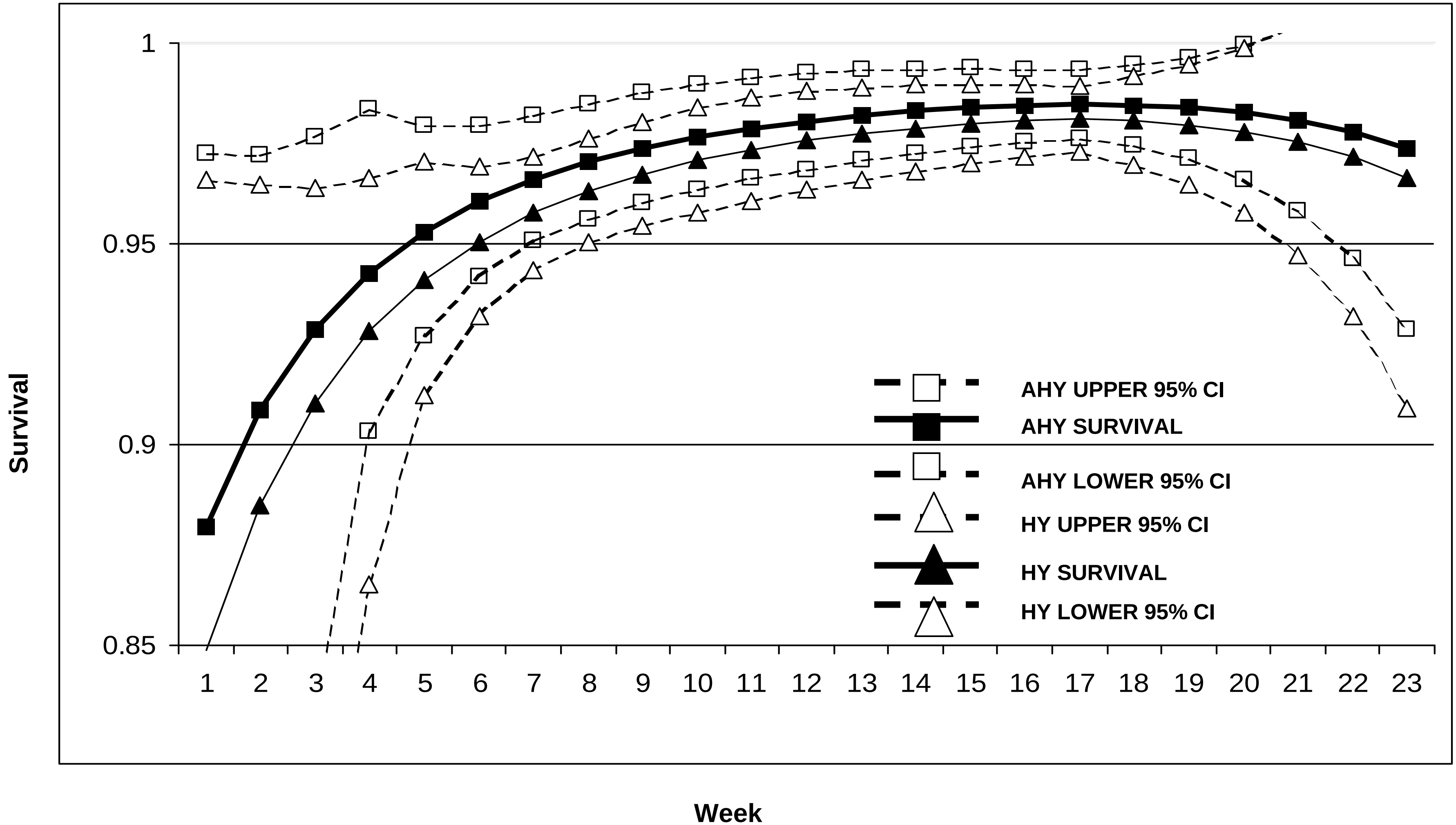


Figure 4. Survival curves and 95% confidence intervals for adult (AHY) and hatch year (HY) female northern pintails radio-tagged and tracked in winter 2003-04 along the Texas mid-coast.



DISCUSSION

Survival of female pintails along the Texas Coast is 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, the survival rates I report are lower than for similar studies using harness-type transmitters to estimate overwinter survival and harvest rates of mallards and American black ducks (*Anas rubripes*) (Table 2). Most variability among survival estimates is generally attributed to differences in hunting mortality. However, harvest rates from this study were not dramatically greater than harvest rates of pintails in Louisiana (16.5–31.5%; Cox et al. 1998).

In research conducted in the Playa Lakes Region (PLR) of northwestern Texas during the same years as this study, Moon and Haukos (2006) reported survival rates (69–92.5%) of female pintails higher than those of pintails along the Texas mid-coast, with the 2002–03 PLR survival estimate the highest survival rate reported from any pintail telemetry study. Comparison between the 2 studies is unique in that radiotransmitters from the same source (allocated randomly) were used on all females and radiotransmitters were fitted using similar techniques, with females from both studies relocated and tracked during migration in Nebraska. Moon and Haukos (2006) reported 34 mortalities out of a possible 327 tagged females, with 26 (76%) occurring during the second year. Moon and Haukos (2006) hypothesized that the higher mortality reported in 2003–04 was due to dry habitat conditions in the PLR, as total rainfall in the PLR was the lowest since 1911 and <1% of playas were wet during midwinter inventories. Eighty-eight percent and 34% of mortalities occurred during 2002–03 and 2003–04 pintail hunting seasons in the PLR, respectively, with only

Table 2. Survival, harvest-related, and nonhunting mortality rates of wintering female dabbling ducks estimated from studies using harness-type radio-transmitters (Dwyer 1972).

Species	Region	Days	Age[1]	Survival rate (Mean, SE)		Harvest related rate	Nonhunting mortality rate	Reference
Northern Pintail	Mexico	107	AHY, HY	0.910	NR	0.048–0.103	0–0.019	Migoya and Baldassare 1995
Northern Pintail	California	180	AHY	0.874	0.031	0.041–0.087	0.013–0.076	Miller et al. 1995
Northern Pintail	California	210	AHY; HY	0.756; 0.654	NR	NR	NR	Fleskes et al. 2002
Northern Pintail	Louisiana	147	AHY	0.714	0.045	0.165	0.145	Cox et al. 1998
			HY	0.550	0.068	0.315	0.196	
Northern Pintail	Texas	119	AHY, HY	0.925	NR	NR	NR	Moon and Haukos 2006
		134	AHY, HY	0.694				
Northern Pintail	Texas 2002–03	175	AHY; HY	0.408; 0.320	NR	NR	NR	This study
	Texas 2003–04	183	AHY; HY	0.396; 0.309				
Mallard	Arkansas,	70	AHY	0.840	NR	0.120	0.040	Reinecke et al. 1987
	Mississippi		HY	0.700	NR	0.190	0.011	
Mallard	Texas	100	AHY, HY	0.777	0.040	0.018	0.210	Bergan and Smith 1993
Mallard	Arkansas	30	AHY, HY	0.993	0.014	NR	0.007	Dugger et al. 1994
American Black	New Jersey,	59	AHY	0.729	0.058	0.149	0.143	Conroy et al. 1989
Duck	Virginia		HY	0.599	0.048	0.165	0.282	
American Black	Maine,	76	HY	0.593	0.060	NR	0.306	Longcore et al. 1991
Duck	New Brunswick							

Age[1] = AHY (after-hatching year); HY (hatching-year); NR (not reported); GC (Gulf Coast), RP (Rice Prairies)

4 due to hunter harvest. The Texas mid-coast accounted for 50% (2 pintails) of the hunter harvested PLR birds during 2003–04, as one female was harvested near El Campo in Wharton County. Mortality in the PLR due to hunting is much lower than on the Texas coast. Additionally, Moon (2004) found that pintails engaged in dry field feeding, presumably due to exhaustion of wetland food resources (Sheeley and Smith 1989, Smith and Sheeley 1993), and speculated that birds were subjected to increased exposure to predation during this time. I found no evidence of dry field feeding by pintails in our study (Chapter 2). Research in the PLR also indicated that birds in better condition at time of capture experienced higher overwinter survival (Moon and Haukos 2006). My results did not show a similar relationship between body condition and survival rates of pintails on the mid-coast.

A small sample of female pintails in New Mexico and Texas were instrumented with PTTs (Platform Terminal Transmitters; Haukos et al. 2006) during our study and results from that study appeared to corroborate our findings. Survival of female pintails was 73% in New Mexico (n = 15) and 75% in the PLR (n = 20) (Haukos et al. 2006). However, only 5 of 20 (25%) females tagged on the lower- and mid-coasts of Texas in 2002 and 2003 (10 each location) survived winter (Haukos et al. 2006). It should be noted that when interpreting these results, small sample sizes were used in the PTT studies. However, results corroborate findings from my VHF telemetry research in these regions.

The degree of temporary interregional movements of females tagged in the PLR to the mid-coast of Texas was small. Two females radio-tagged in the PLR were located and tracked in the study area in 2002–03, with PLR females using habitats along the Texas mid-coast similar to those radio-tagged in this study. A third female from the PLR was reported shot in Wharton County on 5 January 2004. No sightings or reports of birds captured in this study were made in the PLR, supporting site-specificity for pintails along the Gulf Coast during winter (Hestbeck 1993*a*). Furthermore, we only recorded 1 known mortality (Texas lower-coast) outside the primary study area (mid-coast).

The extent and timing of hunting mortalities varies regionally for pintails. Harvest-related mortality accounted for 36% of total mortality across the 2 years of my study. However, it was not as high as hunting mortality in California (83%; Fleskes et al. 2002), assuming that the unknown fates in my study were not harvest related. In southwestern Louisiana, Cox et al. (1998) reported high hunter harvest, especially for HY females. The risk ratio for HY females in Louisiana indicated that HY females were 1.8 times more likely to die than AHY. My findings show similar results for HY females in that they are 1.3 times more likely to die than AHY females. Cox et al. (1998) attributed lower survival of HY females to being more naive than AHY, presumably due to lack of experience on the wintering grounds. Both studies were conducted during periods of restricted pintail harvest (30 day season, 1 bird daily bag in Louisiana). In Mexico, hunting was the primary cause of mortality, although survival was high (91%) (Migoya and Baldassare 1995).

Overwinter survival of female pintails along the Texas coast has apparently decreased since the mid-1960s and 70s. Hestbeck (1993*b*) summarized annual survival rates of female pintails throughout coastal Louisiana and Texas estimated from banding on the wintering grounds, and found survival to be 67% and 70% during 1964–1966 and 1976–1978, respectively. Similar findings for males during the same periods were 73% (1964–1966) and 76% (1976–1978) (Hestbeck 1993*b*). Cox et al. (1998) reported similar survival estimates for AHY females in Louisiana (71%).

Lowered non-breeding season survival could potentially have negative impacts on pintail population growth rates. Research by Hoekman et al. (2002) revealed that survival of adult female mallards outside the breeding season only accounted for 9% of the variation in population growth rate, while sensitivity analyses with pintails indicate that overwinter survival on pintail population growth is not that different than mallards (Robert Clark, Canadian Wildlife Service, personal communication). **However, the low variability in overwinter survival of mallards and the large geographic variation in overwinter survival of pintails may call for researchers to reexamine "mallard models" that are used to explain pintail populations.**

Lowered reproduction can also cause negative impacts on population growth rates (Johnson et al. 1987, Hoekman et al. 2002). Findings by LaGrange and Dinsmore (1987) with female mallards suggest that lipid storage on wintering areas can impact migration and that reserves that are replenished at spring stop-over sites have more direct bearing on energy required for the first nest attempt. Since pintails have a low propensity to renest once on the breeding grounds (Austin and Miller 1995, Northern Pintail Workshop 2003), pintails that leave the wintering grounds in poor condition will be less likely to successfully reproduce.

Mid-winter surveys along the Texas coast have averaged nearly 380,000 pintails during the past decade, and about 500,000 since 1955 (Haukos 2003; Texas Parks and Wildlife Department, unpublished data). Overwinter survival may have large effects on pintails compared to other ducks as they spend a greater portion of their annual cycle on wintering grounds. I noticed that pintails arriving in early October concentrated in large flocks (estimated 3,000–20,000 birds) in a few specific areas, primarily on palustrine managed wetlands, such as second-cropped or early-flooded rice fields and Texas Prairie Wetland Project (TPWP) sites. Throughout October–November, some pintails departed coastal areas to the Garwood and Lissie rice prairies presumably for first- and second-crop rice fields and fallow rice fields as they were flooded for the regular waterfowl season. Stutzenbaker (1988) also reported the movement of large numbers of mottled ducks (*Anas fulvigula*) from coastal areas into the rice prairies, especially for second-crop rice at this time of year.

Habitat conditions for pintails and other dabbling ducks were extremely favorable in South Texas during the study, while hunting and other disturbances are presumed to be minimal due to the relative inaccessibility of large South Texas ranches (Ballard et al. 2004). Ballard et al. (2004) found a low proportion of immature pintails wintering in the Laguna Madre and suggested that HY birds may need to winter in more productive habitats (e.g., rice prairies). Similarly, Fleskes et al. (2002) suggested that HY females may be less efficient at improving body condition upon arrival on the wintering grounds.

Several different factors may have contributed to the lower harvest-related mortalities detected during 2003 as only one incidence of 21 harvest-related pintails occurred along the immediate Gulf Coast during the second year. Illegal hunting activities (e.g., hazing of waterfowl with aircraft and air-boats, illegal shooting on MFW-ANWR, etc.) influenced our ability to accurately assess timing of foraging flights, and may have adversely affected pintail survival, especially during the first year, as illegal activities were observed less frequently in 2003. In addition, no dabbling duck hunting occurred on a large ranch adjacent to the northern border of MFW-ANWR during the second year, providing pintails and other ducks additional refuge area (e.g., flooded current and fallow rice).

Estimates of hunter effort from Texas' Harvest Information Program show a 25.7% decrease from 510,400 hunter days in 2002 to 379,200 hunter days in the 2003 hunting season in Texas (Kruse 2004). In an area that supports 55% of the active waterfowl hunters and typically accounts for 52% of the total annual harvest for Texas (Gulf Coast Prairies and Marshes; Texas Parks and Wildlife Department, 1982–2005 unpublished data), hunter activity may have impacted survival. Direct hunter-harvest was less of a factor along the immediate coast than in the rice prairies (both years combined), indicating that natural causes of mortality may be more prevalent in coastal habitats. However, I found higher hunter-harvest along the immediate coast during the first year. Higher incidence of crippling loss in the rice prairies was also evident. Macartney rose (*Rosa bracteata*) appeared to be associated with location of mortalities, indicating that predators may be using them as refuge or places of ambush, especially when they occur along rice field margins. Macartney rose may also hinder recovery of shot waterfowl.

Unknown fates of pintails made up a significant proportion of the mortalities recorded in this study, most of which are assumed to be non-hunting related. Stutzenbaker (1988) commented on the diverse predator and scavenging community along the Texas coast and speculated that mammals were the most significant predator of nesting mottled ducks. He also stated that the American alligator (*Alligator mississippensis*) was the single most efficient predator of adults and ducklings, especially during dry years. He also suggested that migrating red-tailed hawks (*Buteo jamaicensis*) may take a small number of adult mottled ducks annually, as migrants are present on the Gulf Coast from October-April at densities of 1-2 hawks per 259 hectares (Stutzenbaker 1988). In addition, work completed at the J. D. Murphree Wildlife Management Area revealed that waterfowl carcasses that were randomly placed seldom remained intact for longer than 1 day (D. Lobpries, Texas Parks and Wildlife Department, personal communication). Although I did not set out to examine cause-specific mortality, my research suggests that 8 hr mortality sensors were too long as several mortalities of undetermined fate were located while still emitting an alive signal, indicating recent predator or scavenger presence.

The resulting large number of unknown fates were due in part to possible mammalian predation; however, concern with excessive scavenging precluded me from making inferences. Because of the diverse scavenging community along the Texas Gulf Coast, I was not able to confidently determine cause of death for many of the mortalities. Given the intense sampling schedule and the time lags between death, mortality sensor activation, mortality detection, and acquiring access to property, many carcasses had been scavenged beyond our ability to accurately determine cause of death. Frequent encounters with raccoons, coyotes (*Canis latrans*), domestic dogs (*Canis familiaris*), and bobcat (*Felis rufus*) occurred in habitats used by pintails. Coyotes were observed carrying carcasses to areas where remains of several radiotagged pintails along with other duck and goose carcasses were observed. Two coyotes were observed catching and killing a snow goose at night on MFW-ANWR (using night-vision equipment), further illustrating the capability of coyotes to kill waterfowl. Bobcat tracks and sign were observed near some pintail mortalities, especially on rice levees near Macartney rose. Evidence of carcass remains, particularly the distribution of feathers and down and how the bird was consumed, indicate that bobcats were feeding on a few pintail carcasses (M. Tewes, Caesar Kleberg Wildlife Research Institute, personal communication). Initial cause of death for these females was still unknown, resulting in our pooling of suspected mammalian depredations with other undetermined fates. Peregrine falcons (*Falco peregrinus*) and great horned owls (*Bubo virginianus*) appeared to be in abundance in the study area, particularly in coastal areas. Great horned owl pairs were observed at MFW-ANWR, viewed with night-vision goggles, perched on mixed brush, Chinese tallow (*Sapium sebiferum*), and power poles overlooking refuge roost areas. Great horned owls are known to consume waterbirds roosting on open water and have been documented carrying single ducks back to their nests (Houston et al. 1998). In addition, several incidences of Great Horned Owl predation were reported for mallards wintering in southwest Louisiana (**P. Link, personal communication**). Similarly, peregrine falcons were observed hunting waterfowl and waterbirds in the same habitats, particularly in early migration when large numbers of teal passed through the mid-coast. The peregrine falcon has been documented killing at least 28 species of waterfowl in Alaskan tundra landscapes, with some as large as Sandhill cranes (*Grus canadensis*) and Brant (*Branta bernicla*) (White 2002). During both years of the study, I observed red-tailed hawks, peregrine falcons, and great-horned owls taking waterfowl in my study area. Based on the predator community and observations in the field, I believe that raptors are a much more important source of mortality on female pintails than I was able to confirm with my data. My presumed high incidence of natural mortality suggests that further research should be directed in understanding cause-specific mortality for pintails wintering along the Texas mid-coast and the changing predator community as a result of anthropogenic and exotic/invasive influences. It should also be noted that a portion of the unknown mortalities could also be attributed to crippling loss. In addition, increased disturbances from hunting activity could lead to more exposure to predation.

Our results were similar to work by Bergan and Smith (1993) and Moon and Haukos (2006) in that natural mortality factors were the main cause of dabbling duck deaths. Eighty-eight percent of both mallard (Bergan and Smith 1993) and pintail (Moon 2004) mortalities were attributed to natural or unknown causes. For pintails in the mid-coast of Texas, natural predation, disease, and unknown causes totaled 63% of all mortalities. Because a large proportion of the mortalities in this study were individuals that spent a considerable amount of time on non-hunted areas (Chapter 2) and appeared to have limited exposure to hunting, it seems that natural causes are an important source of mortality on the Texas Coast.

Many sources of disturbance were observed during this study (e.g., anthropogenic, predator, weather, other waterfowl, etc.) and may have had negative impacts on pintail survival. Moon (2004) and Cox and Afton (1996) both reported periods of large amounts of disturbance, especially during the hunting season. If pintails are displaced to lower quality habitat or are forced to restrict their foraging bouts during periods of intense disturbance, they may be in reduced condition and forced to feed longer or at more vulnerable times (e.g., at night), possibly making pintails more susceptible to predators.

In conclusion, survival of female pintails along the Texas Coast appears to be low. A better understanding of sources of mortality of pintails along the Texas Coast is a logical next step to increase our knowledge of pintail ecology in this important wintering area. Low winter survival in a wintering area that holds the majority of pintails in the Central Flyway could have impacts noticeable at the continental level. The late winter decline in survival during the second year of the study was likely driven by drying habitat conditions (Chapter 2). I noted large-scale habitat loss as a result of landowners/managers releasing water during the last week of the waterfowl season in 2004. This coincided with a drop in survival during February and March during the second year. Landowner education and incentive programs such as the TPWP could help moderate habitat loss at a time when birds prepare for spring migration (Chapter 2).

CHAPTER II

HABITAT USE AND MOVEMENTS
OF FEMALE NORTHERN PINTAILS
WINTERING ALONG THE MID-COAST OF TEXAS

Because of pintails' reliance on stored reserves during nesting (Krapu 1981, Esler and Grand 1994), wintering habitat quality along the Texas Coast may play a critical role in recruitment. The relationship between quality of wintering habitat conditions and breeding population dynamics is important, as habitat conditions the previous winter may influence reproductive parameters (Milne 1976, Fredrickson and Drobney 1979, Kaminski and Gluesing 1987). Heitmeyer and Fredrickson (1981) found a high correlation between winter habitat conditions and recruitment the following spring in mallards. In Missouri, Heitmeyer (1988) noted that completion of annual cycle events (e.g., pairing) early in winter favorably influenced carcass composition of female mallards, speculating that these females may realize a reproductive advantage, especially following wet winters. Similarly, Raveling and Heitmeyer (1989) found that pintail production was correlated to the quality of wintering habitat the previous winter.

In winters with above average rainfall, dabbling ducks should utilize the increased native food base and respond as follows: (1) increased body condition (e.g., increased carcass mass, gizzard mass, and fat), (2) earlier courtship and formation of pair bonds, (3) rapid molting and earlier attained alternate plumage, and (4) potentially earlier or more timely departure from wintering areas (Sheeley and Smith 1989). Furthermore, Bergan and Smith (1993) found that female mallard survival in the PLR was greatest during wet years. Research by Reinecke et al. (1982) with female American Black Ducks (*Anas rubripes*) in

Maine, and Haramis et al. (1986) with male canvasbacks (*Aythya valisineria*) banded on Chesapeake Bay provide additional information indicating positive relationships between winter habitat conditions and survival of waterfowl. In contrast to wet years, Miller (1986*a*) found that wintering pintails in the Central Valley of California experienced greater losses of body mass during dry winters, probably due to reductions in food and habitat availability. Research conducted along the lower Texas coast by Ballard et al. (2006) suggests that pintails relied more on endogenous reserves during winter of a dry year. Similarly, Fleskes et al. (2002) reported low body condition for pintails on wintering areas during drought conditions. Additionally, pintails in the Central Valley responded to reduced resource availability by adjusting their behavioral and physiological activities in that loafing and diurnal feeding increased, whereas courtship decreased (Miller 1985), and the onset of the prebasic molt of female pintails was delayed (Miller 1986*b*).

The importance of rice fields to waterfowl has been well documented. For example, Miller (1987) found that rice was the most important food of pintails wintering in the Sacramento Valley of California, with flooded fields providing an additional invertebrate food source in late winter. In southwestern Louisiana, pintails extensively used shallowly flooded rice fields, particularly at night, to meet their energy requirements (Cox and Afton 1997). Historically, rice fields can produce more energy per unit area than native wetlands and support more waterfowl overwinter per unit area (Fredrickson and Taylor 1982).

Rice in Texas is generally planted by 15 March and is harvested by July and August (Stutzenbaker 1988). When adequate growing conditions occur, a second-crop of rice can be produced 50 days post harvest, with yields varying from 33–50% of the initial crop (Stutzenbaker 1988). Second-cropping of rice in

Louisiana and Texas paired with standing rice left unharvested on levees (Lobpries 1990) increases rice availability, resulting in an abundant food supply for pintails and other water birds (Esslinger and Wilson 2001).

Recent studies in the Mississippi Alluvial Valley (MAV) have shown that rice left after harvest in August-September is mostly depleted (waste-rice abundance decreased 79–99% during autumns 1995–1996) when waterfowl arrive in late November and early December, with waste grain apparently sprouting, decomposing, and/or being consumed by rodents and other birds before the appearance of waterfowl (Manley 1999). Additional work by Stafford (2004) revealed that the carrying capacity of rice fields in the MAV for waterfowl may be overestimated by 52–83%. While the rice research provides important data concerning rice availability in the MAV, it may not satisfactorily describe the second-cropped rice regime in Texas.

Rice availability is further decreased by increasingly earlier harvests from improved cultivars and more effective mechanical harvest techniques. In 2006, Cocodrie, Chenier, and Clearfield varieties accounted for over 72% of the planted acreage in Texas, with more hybrid varieties anticipated in 2007 (Smith 2007). Although record yields occurred in 2006 with these new cultivars, Texas rice acreage was reduced to only 59,711 hectares, the lowest harvest since 1934 and only 25% of peak production (Smith 2007).

Undoubtedly, wetland conditions will effect habitat use by pintails wintering along the Texas Coast. A basic understanding of pintail habitat use and movements (both locally and regionally) is fundamental to habitat management and refuge establishment. This basic understanding also is critical for effective land management and acquisition programs by federal, state, and private agencies. Habitat conservation is imperative for meeting waterfowl population objectives of the Gulf Coast Joint Venture (GCJV) of the North American Waterfowl Management Plan (NAWMP). Habitat objectives are based on the assumption that food availability is the limiting factor for wintering ducks in the GCJV (Esslinger and Wilson 2001). Three major waterfowl habitats are available as defined by the GCJV Texas Mid-Coast Initiative: (1) agricultural lands dominated by rice and pasture, (2) coastal marsh, and (3) seagrasses with their associated estuarine wetlands (Wilson and Esslinger 2002). Current estimates in the GCJV Texas Mid-Coast Initiative area of wintering waterfowl foraging habitat reveal a deficit of almost 3,100 hectares for early-flooded palustrine habitat (e.g., first crop rice, TPWPs or similar managed moist-soil, etc.) and a deficit of over 33,000 hectares for late-season palustrine flooded habitat (e.g., second crop harvested and unharvested rice, TPWPs, etc.) (Michael Brasher, GCJV, unpublished data). Furthermore, the GCJV's primary goal is to provide habitat for waterfowl in winter and ensure that they survive and return to the breeding grounds in optimal condition, ultimately providing for mid-winter population objectives of 775,755 and 1.07 million pintails in the Texas mid-coast and entire Texas Coast, respectively (Wilson and Esslinger 2002).

I initiated pintail research along the mid-coast of Texas to examine habitat use and movements of female pintails during winter.

Specifically, my objectives were to:

(1) Estimate diel (daytime and nighttime) use of habitats by female pintails, with habitats defined with respect to vegetation type and hydrology (Cowardin et al. 1979).

(2) Estimate habitat availability and preference for pintails along the mid-coast of Texas.

(3) Estimate distance of daily (both morning and evening) foraging flights for

female pintails.

This study was designed to test the following research hypotheses:

H_1: There will be temporal differences in diurnal and nocturnal use of habitats by female pintails.

Prediction 1: Female pintails will increase nocturnal use of foraging habitats during periods of intense hunting pressure.

Prediction 2: Female pintails will increase the array of habitats used later in winter because of depletion of resources in preferred habitats.

H_2: Distance of daily foraging flights by female pintails will depend on season and year.

Prediction 1: Distance of daily foraging flights for female pintails will be greater during dry winters when resources are more limited.

Prediction 2: Daily foraging flights for female pintails will be later in the day during periods of intense hunting pressure.

METHODS

Monitoring

I expanded the GCJV Texas Mid-Coast Initiative area to include 20 counties as the primary study area and also surveyed an additional 38 counties in east central Texas and within the upper- and lower Texas Coast. During 2002–03, diel habitat utilization locations were obtained once every 7–10 days on average. In 2003–04, effort was doubled to obtain a diurnal and a nocturnal habitat use location every 5 days. For each year, I attempted to divide sampling into 5 diurnal and 2 nocturnal subdivisions to minimize repeated locations for an individual in the same time periods. In addition, I attempted to collect the diurnal and nocturnal locations for an individual pintail within a given time period 2–3 days apart when possible. Aerial locations were communicated to technicians in trucks equipped with 4-element, null-peak telemetry antennas for accurate estimation of locations using triangulation. Additional capture and monitoring methods are referenced in Chapter I.

Electronic compasses (Azimuth ® 1000R, KVH Industries, Inc., Middletown, RI) were used to increase tracking efficiency while yielding accurate estimates of locations without sacrificing precision (Cox et al. 2002). The antenna systems were calibrated empirically to known locations of randomly placed beacon transmitters to within $\pm 0.5^{\circ}$ accuracy following Cox et al. (2002). Accuracy of the radiotelemetry system is important because poor location estimation can lead to bias and imprecision of estimations of habitat use and movement (White and Garrott 1986). Additionally, use of electronic compasses should produce more accurate estimates of location when marked pintails are moving or when vehicle orientation is problematic (Cox et al. 2002). 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. A minimum of 3 azimuths were taken for each female from telemetry vehicles and a minimum threshold of 20 ha was used for calculating the minimum acceptable error ellipse estimate in LOAS, similar to techniques used to track pintails in Louisiana (Cox and Afton 1997). When error ellipses exceeded 20 ha, additional azimuths were acquired when terrain and access permitted, until the estimated error ellipse was reduced below the threshold. When vehicle orientation was problematic or pintails were $\geq$ 7 km from truck access points the error ellipses were allowed to exceed 20 ha providing the habitat type was monotypic throughout the entire ellipse area.

I attempted to assess morning (from 2 h before sunrise until 0.5 h after sunrise) and evening (from 2 h before sunset until 0.5 h after sunset) foraging flights of randomly selected females following Cox and Afton (1996). Beginning and ending habitat types were noted, unless the bird made no movement out of the original wetland.

Statistical Design

Habitats were delineated based on Cowardin et al. (1979); however, use by radio-tagged pintails determined the degree of habitat lumping in order to minimize the number of zero observations occurring in habitats. Compositional analysis (Aebischer et al. 1993) was considered but was not suited for the analysis, due to the large number of potential zero values (Bingham and Brennan 2004). Therefore, I used the Neu et al. (1974) approach for analysis of use-availability data.

Habitat use-availability was examined for each year, duck hunting season, hunted vs. non-hunted (refuge type habitats), and diel (diurnal vs. nocturnal) use.

SYSTEM, SUBSYSTEM, and CLASS variables described habitat via the Cowardin et al. (1979) system. The Coastal Change Analysis Program (C-CAP; NOAA 2006) digitized habitat classification system was used to quantify habitat availability. I investigated differences in habitat use between diurnal and nocturnal locations, hunting and non-hunting periods, hunted and non-hunted areas, and altered and natural wetlands.

Habitat use-availability was examined using the variable FREQ (occurrence of an individually tagged pintail within each individual habitat type used per year; each occurrence only counts as 1 measurement per individual per habitat type) and by total number of observations (TOTAL; all habitat use locations per individually marked pintail for each habitat type used during each year; multiple occurrences per individual for each habitat type) using Neu et al. (1974). Habitats with zero observations were omitted.

I investigated the use-availability for both the total number of observations (TOTAL: 2,134 and 4,888 habitat use locations for 2002–03 and 2003–04, respectively) and the number of individual habitat use observations per radio-tagged pintail [FREQ: 315 radio-tagged pintails; e.g., each unique habitat type was recorded once per marked pintail (350 and 365 locations per 2002–03 and 2003–04, respectively)]. I used both TOTAL and FREQ due to criticisms of using multiple observations per bird and resulting independence issues.

Geospatial Design

Accuracy and precision of triangulations were assessed on-site using LOAS, Landsat 7 Enhanced Thematic Mapper Plus (ETM+) imagery (L7), and U. S. Bureau of the Census TIGER (Topologically Integrated Geographic Encoding and Referencing) geographic vector data files (downloaded from http://www.geographynetwork.com). TIGER data files (e.g., road, rail, landmarks, urban areas, etc.) were used in ArcGIS 9.2 (ESRI, Redlands, CA) as graphic overlays in combination with LOAS software to improve the tracking efficiency of technicians unfamiliar with the terrain of the Texas mid-coast. In addition, ArcMap was used to create shapefiles for the MFW-ANWR near Indianola to assist with tracking. By using the 11 November 2002 L7 multispectral image for a reference, 6 control points were used to georeference the MFW-ANWR bitmap (courtesy ANWR) to integrate the image into ArcGIS 9.2.

To determine habitat availability based on classification of habitat types using supervised classification, I used Erdas Imagine 9.1 (Leica Geosystems Inc., Norcross, GA) and standardized vegetation indices using L7 imagery obtained from partners (e.g., Ducks Unlimited, Inc.) and downloaded from Texas Synergy (http://synergy1.csr.utexas.edu/DataQuery/index.jsp). I also used the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center Coastal Change Analysis Program (C-CAP; NOAA 2006) to assess habitat availability. WATER (C-CAP class name; defined as including all areas of open water with less than 25% coverage of vegetation or soil) was re-coded and split into Lacustrine and Estuarine Subtidal [modified C-CAP class names based on Cowardin et al. (1979)] in Erdas Imagine 9.1 to account for the lack of habitat separation in the original C-CAP dataset.

Kernel (95%) estimators for core area of use by tagged pintails were generated with ArcView 3.2 using the Animal Movement Extension in Home Range Tools (HRT) (Rodgers et al. 2005) in ArcGIS 9.2. A smoothing H of 1.0 for both fixed and adaptive Kernel estimators was analyzed for each year and both years combined. Contours of 0.95 or 95% were estimated. The Kernel analysis tool in Arc GIS 9.2 was used to create the actual size of the utilized study area each year using all pintail locations for that year. All telemetry locations were buffered based on their mean error ellipse value estimated by LOAS (radius; 140 m and 201 m for terrestrial and aerial, respectively).

Habitats that were within the 95% Kernel for each year but were not biologically available to pintails (e.g., C-CAP classifications: high, medium, and low intensity developed areas; deciduous and evergreen forests, etc.) were excluded. In addition, habitats that could have potentially wintered pintails but had zero utilization (e.g., C-CAP classifications: grasslands, palustrine forested wetlands, palustrine scrub/shrub, estuarine forested wetlands, and estuarine scrub/shrub) were excluded from the analysis.

Daily movements (either morning or evening flights) were analyzed for each year and recorded as a mean distance of travel (meters). Additionally, movement data were analyzed using the spatial occurrence of telemetry locations with Texas Prairie Wetland Project (TPWP) sites within the 95% Kernel. The Clip function was used in ArcGIS 9.2 to obtain the total area of TPWP sites included within the combined 95% Fixed Kernel each year. Positions were then buffered in ArcGIS 9.2 using the radius measurement (average telemetry error) to account for the error estimates. Position estimates for birds that were flushed (e.g., false mortalities) were made by walking to the point where the bird flushed and entering a GPS coordinate (mean error of 4 m).

RESULTS

I captured and attached radiotransmitters to 315 (141 adults, 174 immatures) female pintails in October-November 2002 and 2003. Additional capture information, along with climatological data and study area description can be found in Chapter I. Habitat use locations were collected over a 175-day wintering period during 2002–03 and 183-day wintering period for 2003–04. December had the most habitat utilization locations (combined terrestrial and aerial) by month for each year of the study, while recorded habitat use locations more than doubled for each month during 2003–04 when compared to the previous year (Table 3).

Ninety-five percent Kernel estimations of all pintail locations for 2002–03 and 2003–04 separately (Figures 5–6) and both years combined indicated that there was a difference in core area use between the 2 years; therefore, all analyses were conducted for each year separately.

Error Estimates

The error ellipses calculated by LOAS for ground telemetry for both years combined produced a mean ground error of 6.14 ha. Mean error for aerial locations was calculated by using the Area = Pi*r^2 formula and was estimated to be 12.7 ha. Aerial error was based on a mean altitude of 530 m (92 altitude measurements) and was calculated by comparing aerial positions to known randomly placed beacon positions and mortality locations. Mean error estimates were **140 m and 201 m** for ground and air locations respectively.

Diel Habitat Use

A total of 1,711 ground and 423 air locations were obtained for habitat use during the first year (2,134 total). During the second year 4,260 ground and 628 air locations were obtained (4,888 total).

Table 3. Number of combined (terrestrial and aerial) habitat utilization locations of female northern pintails obtained per month during 2002–03 and 2003–04 along the mid-coast of Texas.

Year	October	November	December	January	February	March	April
2002–03	17	100	650	609	451	273	34
2003–04	0	128	1,501	1,209	1,125	827	98
TOTAL	17	228	2,151	1,818	1,576	1,100	132

Figure 5. Core area of use for radio-tagged female pintails using 95% Kernel estimation for 2002-03.

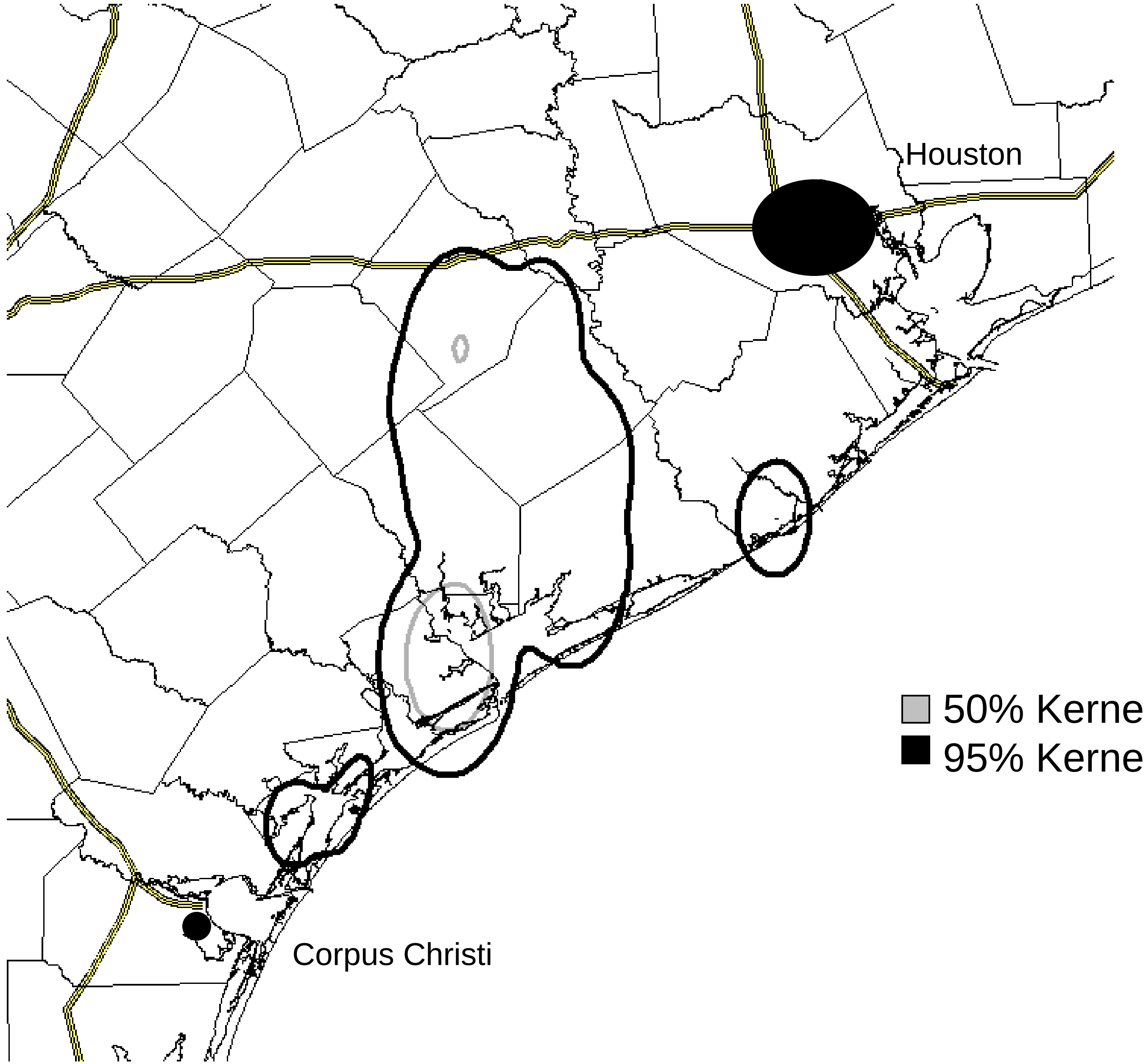
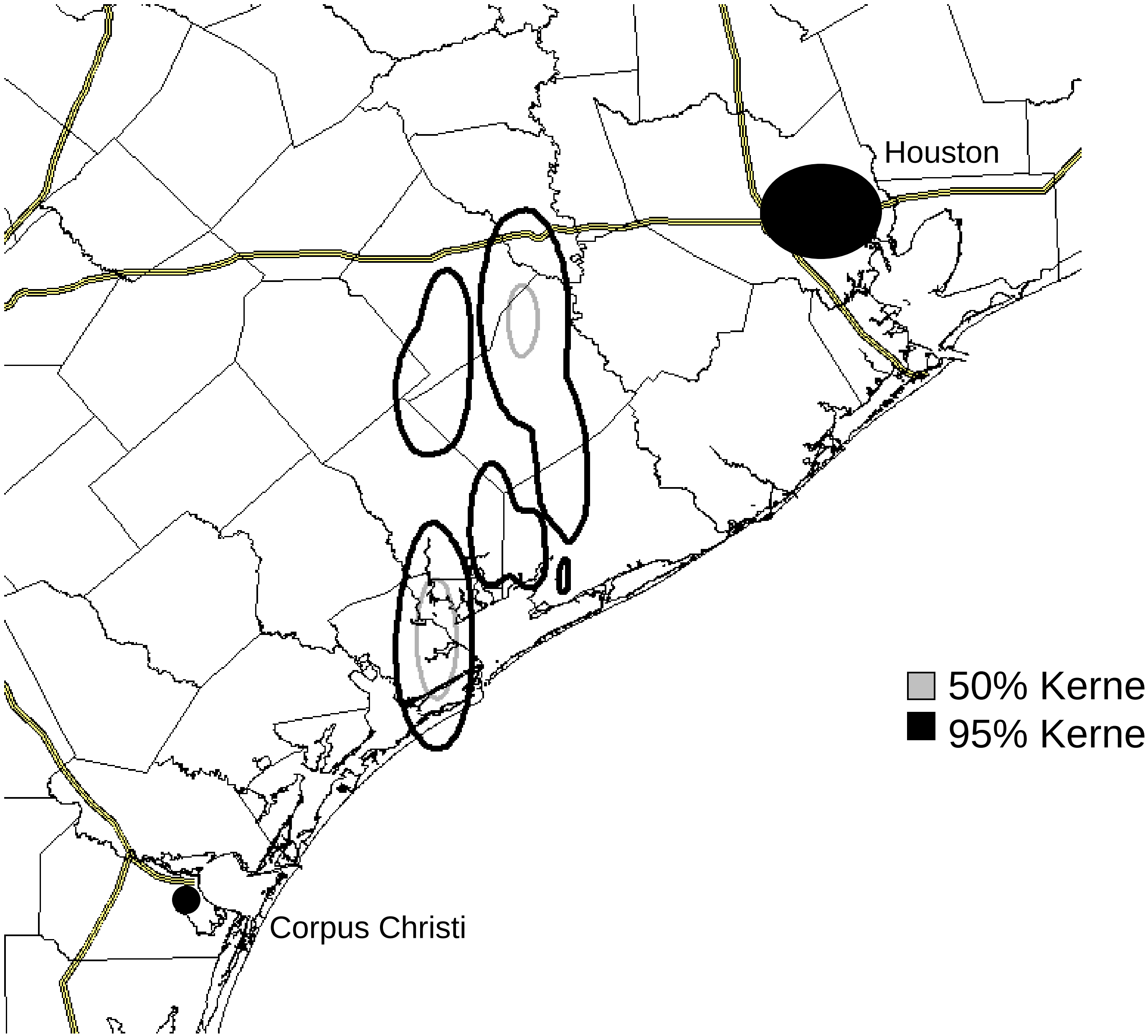


Figure 6. Core area of use for radio-tagged female pintails using 95% Kernel estimation for 2003-04.



For 2002–03, 1,174 (55%) locations were diurnal while 960 (45%) locations were nocturnal. During the second year, 2,503 (51%) locations were diurnal and 2,385 (49%) locations were nocturnal.

Duck Season

Approximately 50% of all locations were obtained during the regular duck season each year. Regular duck season was considered as the hunting season even though the pintail season was restricted to the last 39 days of the regular season each year. During the first year, 73% (1,557 locations) of all locations were collected on areas that were hunted while the remaining 27% (577 locations) were collected on non-hunted areas. In 2003–04, 3,276 (67%) locations occurred on hunted areas and 1,612 (33%) locations occurred on non-hunted areas. Non-hunted areas were defined as areas that were not hunted during the entire regular duck season, including state and federal managed areas as well as goose roosts set aside for traditional light goose hunting within the Texas mid-Coast.

I also examined diel habitat use for hunted and non-hunted lands within both the regular duck season and the non-hunting period for each year (Table 3). In both years of the study, diurnal and nocturnal use of hunted lands increased during the non-hunting period.

Habitat Utilization

Palustrine wetland habitats were highly utilized by pintails during both 2002–03 (94.3%) and 2003–04 (98.8%) (Tables 4–5). Of the palustrine habitat use in 2002–03, 91.3% (1,838 locations) occurred in emergent wetlands. During the second year, emergent wetlands accounted for 87.9% (4,247 locations) of the palustrine total. Use of estuarine habitats by radio-marked female pintails

Table 4. Cowardin et al. (1979) wetland classification for pintail habitat utilization locations along the Texas mid-coast during 2002–03.

System			Subsystem			Class		
Name	*n*	Percentage	Name	*n*	Percentage	Name	*n*	Percentage
Palustrine	2,013	94.33%	Palustrine	2,013	94.33%	Aquatic Bed	6	0.30%
						Emergent Wetland	1,838	91.31%
						Unconsolidated Bottom	27	1.34%
						Unconsolidated Shore	142	7.05%
Estuarine	97	4.55%	Intertidal	89	4.17%			
			Subtidal	8	0.38%			
Lacustrine	24	1.12%	Littoral	24	1.12%			
TOTAL	2,134	100.00%		2,134	100.00%		2,013	100.00%

Table 5. Cowardin et al. (1979) wetland classification for pintail habitat utilization locations along the Texas mid-coast during 2003–04.

System			Subsystem			Class		
Name	*n*	Percentage	Name	*n*	Percentage	Name	*n*	Percentage
Palustrine	4,830	98.81%	Palustrine	4,830	98.81%	Aquatic Bed	9	0.19%
						Emergent Wetland	4,247	87.93%
						Unconsolidated Bottom	43	0.89%
						Unconsolidated Shore	531	10.99%
						TOTAL	4,830	100.00%
Estuarine	44	0.90%	Intertidal	37	0.76%	Aquatic Bed	5	
						Emergent Wetland	32	
			Subtidal	7	0.14%	Unconsolidated Bottom	7	
						TOTAL	44	100.00%
Lacustrine	14	0.29%	Littoral	14	0.29%	Unconsolidated Shore	14	
						TOTAL	14	100.00%
TOTAL	4,888	100.00%		4,888	100.00%	GRAND TOTAL	4,888	100.00%

was low (≤ 4.6%). Lacustrine habitats were utilized the least during both years, ranging from 0.3–1.1%.

Habitat use using modified C-CAP data classification was estimated for both years (Table 6). The most frequently used habitats each year were cultivated (52.6–54.9%) and palustrine emergent wetlands (38.4–41.6%). Pasture accounted for 3.6% of the use during 2002–03 and 2.0% during 2003–04. Estuarine wetland habitats accounted for 4.4% of the total use during the first year while accounting for only 0.9% of the total use during 2003–04. Lacustrine (e.g., lakes, open water areas), developed open space (e.g., parks, golf courses, natural grasses around airports, etc.), and unconsolidated shore (e.g., shoreline, mud flat type habitats) habitats were used minimally by pintails during both years. The total available area was estimated at 1.02 million ha for 2002–03 and 0.52 million ha for 2003–04 (Table 7).

Neu et al. (1974) analysis for each year (diurnal and nocturnal locations combined) using both TOTAL and FREQ revealed that pintails exhibited preference for both cultivated and palustrine emergent wetland habitats each year ($P \leq 0.10$) (Tables 8–11). Palustrine emergent wetlands were preferred for both diurnal and nocturnal locations for both TOTAL and FREQ each year ($P \leq 0.10$) (Tables **12–19**). Cultivated habitats were preferred during both diurnal and nocturnal time periods in 2002–03 using TOTAL (Tables 12–15). Diurnal and nocturnal use of cultivated was proportional to its availability in 2002–03 using FREQ (Tables 16–19). In 2003–04, cultivated habitats using FREQ were preferred during nocturnal hours but were avoided during the day (Tables **16–19**).

Habitat use was examined between hunting and non-hunting periods for each year for both TOTAL (Tables 20–23) and FREQ (Tables 24–27).

Table 6. Modified C-CAP habitat utilization for female northern pintails wintering along the Texas mid-coast during 2002–03 and 2003–04.

	2002–03		2003–04	
C-CAP Class	*n*	%	*n*	%
Cultivated	1,123	52.62	2,683	54.89
Developed Open Space	1	0.05	3	0.06
Estuarine Aquatic Bed	24	1.12	5	0.10
Estuarine Emergent Wetland	62	2.91	32	0.65
Estuarine Subtidal	8	0.37	7	0.14
Lacustrine	12	0.56	19	0.39
Palustrine Aquatic Bed	6	0.28	9	0.18
Palustrine Emergent Wetland	820	38.43	2,031	41.55
Pasture	77	3.61	98	2.00
Unconsolidated Shore	1	0.05	1	0.02
TOTAL	2,134	100.00	4,888	100.00

Table 7. Habitat availability (in hectares) based on 95% Kernel estimation and modified C-CAP classes for 2002–03 and 2003–04.

	2002–03		2003–04	
C-CAP Class	Ha	%	Ha	%
Cultivated	315,897	30.98	202,103	39.23
Developed Open Space	11,412	1.12	5,243	1.02
Estuarine Aquatic Bed	1,127	0.11	480	0.09
Estuarine Emergent Wetland	52,722	5.17	14,661	2.85
Estuarine Subtidal	224,607	22.03	58,746	11.40
Palustrine Aquatic Bed	1,351	0.13	822	0.16
Lacustrine	20,064	1.97	5,903	1.15
Pasture	246,840	24.21	156,576	30.40
Palustrine Emergent Wetland	26,184	2.57	10,105	1.96
Unconsolidated Shore	9,088	0.89	2,521	0.49
Grassland	55,986	5.49	31,484	6.11
Palustrine Forested Wetland	40,202	3.94	20,380	3.96
Palustrine Scrub Shrub	14,222	1.39	6,092	1.18
Estuarine Forested Wetland	3	0.00	1	0.00
Estuarine Scrub Shrub	41	0.00	19	0.00
TOTAL	1,019,744	100.00	515,135	100.00

Table 8. Neu et al. (1974) utilization-availability analysis using 2,134 habitat utilization locations (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	1,123	0.347	741	0.526	0.498-0.554	Preferred	Yes
DOS	11,412	1	0.013	27	0.000	0-0.002	Avoided	Yes
EAB	1,127	24	0.001	3	0.011	0.005-0.017	Preferred	Yes
EEW	52,766	62	0.058	124	0.029	0.020-0.038	Avoided	Yes
EST	224,607	8	0.247	527	0.004	0-0.007	Avoided	Yes
LAC	20,064	12	0.022	47	0.006	0.001-0.010	Avoided	Yes
PAB	1,351	6	0.001	3	0.003	0-0.006	Preferred	No
PEW	26,183	820	0.029	62	0.384	0.357-0.411	Preferred	Yes
PAS	246,840	77	0.271	579	0.036	0.026-0.046	Avoided	Yes
UNS	9,088	1	0.010	21	0.000	0-0.002	Avoided	Yes
TOTAL	909,335	2,134	1.000	2,134	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 9. Neu et al. (1974) utilization-availability analysis using 4,888 habitat utilization locations (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	2,683	0.442	2,161	0.549	0.531-0.567	Preferred	Yes
DOS	5,243	3	0.011	56	0.001	0-0.002	Avoided	Yes
EAB	480	5	0.001	5	0.001	0-0.002	Avoided	No
EEW	14,680	32	0.032	157	0.007	0.004-0.010	Avoided	Yes
EST	58,746	7	0.128	628	0.001	0-0.003	Avoided	Yes
LAC	5,903	19	0.013	63	0.004	0.002-0.006	Avoided	Yes
PAB	822	9	0.002	9	0.002	0-0.003	Preferred	No
PEW	10,105	2,031	0.022	108	0.416	0.397-0.434	Preferred	Yes
PAS	156,576	98	0.342	1,674	0.020	0.015-0.025	Avoided	Yes
UNS	2,521	1	0.006	27	0.000	0-0.001	Avoided	Yes
TOTAL	457,179	4,888	1.000	4,888	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 10. Neu et al. (1974) utilization-availability analysis using 350 individual habitat utilization locations (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	124	0.347	122	0.354	0.288-0.420	Preferred	No
DOS	11,412	1	0.013	4	0.003	0-0.010	Avoided	Yes
EAB	1,127	10	0.001	0	0.029	0.006-0.052	Preferred	Yes
EEW	52,766	27	0.058	20	0.077	0.040-0.114	Preferred	No
EST	224,607	7	0.247	86	0.020	0.001-0.039	Avoided	Yes
LAC	20,064	10	0.022	8	0.029	0.006-0.052	Preferred	No
PAB	1,351	3	0.001	1	0.009	0-0.021	Preferred	No
PEW	26,183	131	0.029	10	0.374	0.308-0.441	Preferred	Yes
PAS	246,840	36	0.271	95	0.103	0.061-0.145	Avoided	Yes
UNS	9,088	1	0.010	4	0.003	0-0.010	Avoided	No
TOTAL	909,335	350	1.000	350	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 11. Neu et al. (1974) utilization-availability analysis using 365 individual habitat utilization locations (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	137	0.442	161	0.375	0.310-0.441	Avoided	Yes
DOS	5,243	2	0.011	4	0.005	0-0.015	Avoided	No
EAB	480	5	0.001	0	0.014	0-0.029	Preferred	No
EEW	14,680	12	0.032	12	0.033	0.009-0.057	Preferred	No
EST	58,746	5	0.128	47	0.014	0-0.029	Avoided	Yes
LAC	5,903	9	0.013	5	0.025	0.004-0.046	Preferred	No
PAB	822	3	0.002	1	0.008	0-0.020	Preferred	No
PEW	10,105	141	0.022	8	0.386	0.321-0.452	Preferred	Yes
PAS	156,576	50	0.342	125	0.137	0.091-0.183	Avoided	Yes
UNS	2,521	1	0.006	2	0.003	0-0.010	Avoided	No
TOTAL	457,179	365	1.000	365	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 12. Neu et al. (1974) utilization-availability analysis using 1,174 diurnal habitat utilization locations (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	623	0.352	413	0.531	0.494-0.568	Preferred	Yes
EAB	1,127	13	0.001	1	0.011	0.003-0.019	Preferred	Yes
EEW	52,766	36	0.059	69	0.031	0.018-0.043	Avoided	Yes
EST	224,607	2	0.250	294	0.002	0-0.005	Avoided	Yes
LAC	20,064	11	0.022	26	0.009	0.002-0.017	Avoided	Yes
PAB	1,351	4	0.002	2	0.003	0-0.008	Preferred	No
PEW	26,184	440	0.029	34	0.375	0.339-0.411	Preferred	Yes
PAS	246,840	44	0.275	323	0.037	0.023-0.052	Avoided	Yes
UNS	9,088	1	0.010	12	0.001	0-0.003	Avoided	Yes
TOTAL	897,923	1,174	1.000	1,174	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 13. Neu et al. (1974) utilization-availability analysis using 960 nocturnal habitat utilization locations (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	500	0.351	337	0.521	0.480-0.562	Preferred	Yes
DOS	11,412	1	0.013	12	0.001	0-0.004	Avoided	Yes
EAB	1,127	11	0.001	1	0.011	0.003-0.020	Preferred	Yes
EEW	52,766	26	0.059	56	0.027	0.014-0.040	Avoided	Yes
EST	224,607	6	0.249	240	0.006	0-0.013	Avoided	Yes
LAC	20,064	1	0.022	21	0.001	0-0.004	Avoided	Yes
PAB	1,351	2	0.002	1	0.002	0-0.006	Preferred	No
PEW	26,184	380	0.029	28	0.396	0.356-0.436	Preferred	Yes
PAS	246,840	33	0.274	263	0.034	0.019-0.049	Avoided	Yes
TOTAL	900,246	960	1.000	960	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 14. Neu et al. (1974) utilization-availability analysis using 2,503 diurnal habitat utilization locations (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	1,417	0.445	1,113	0.566	0.541-0.591	Preferred	Yes
DOS	5,243	3	0.012	29	0.001	0-0.003	Avoided	Yes
EAB	480	3	0.001	3	0.001	0-0.003	Preferred	No
EEW	14,680	12	0.032	81	0.005	0.001-0.008	Avoided	Yes
EST	58,746	2	0.129	323	0.001	0-0.002	Avoided	Yes
LAC	5,903	10	0.013	32	0.004	0.001-0.007	Avoided	Yes
PAB	822	4	0.002	5	0.002	0-0.004	Avoided	No
PEW	10,105	1,005	0.022	56	0.402	0.377-0.426	Preferred	Yes
PAS	156,576	47	0.344	862	0.019	0.012-0.026	Avoided	Yes
TOTAL	454,658	2,503	1.000	2,503	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 15. Neu et al. (1974) utilization-availability analysis using 2,385 nocturnal habitat utilization locations (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	1,266	0.447	1,067	0.531	0.505-0.557	Preferred	Yes
EAB	480	2	0.001	3	0.001	0-0.002	Avoided	No
EEW	14,680	20	0.032	77	0.008	0.004-0.013	Avoided	Yes
EST	58,746	5	0.130	310	0.002	0-0.004	Avoided	Yes
LAC	5,903	9	0.013	31	0.004	0.001-0.007	Avoided	Yes
PAB	822	5	0.002	4	0.002	0-0.004	Preferred	No
PEW	10,105	1,026	0.022	53	0.430	0.404-0.456	Preferred	Yes
PAS	156,576	51	0.346	826	0.021	0.014-0.029	Avoided	Yes
UNS	2,521	1	0.006	13	0.000	0-0.001	Avoided	Yes
TOTAL	451,936	2,385	1.000	2,385	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 16. Neu et al. (1974) utilization-availability analysis using 296 individual diurnal habitat utilization locations (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	117	0.352	104	0.395	0.323-0.467	Preferred	No
EAB	1,127	7	0.001	0	0.024	0.001-0.046	Preferred	No
EEW	52,766	16	0.059	17	0.054	0.021-0.087	Avoided	No
EST	224,607	2	0.250	74	0.007	0-0.019	Avoided	Yes
LAC	20,064	9	0.022	7	0.030	0.005-0.056	Preferred	No
PAB	1,351	3	0.002	0	0.010	0-0.025	Preferred	No
PEW	26,184	115	0.029	9	0.389	0.317-0.460	Preferred	Yes
PAS	246,840	26	0.275	81	0.088	0.046-0.130	Avoided	Yes
UNS	9,088	1	0.010	3	0.003	0-0.012	Avoided	No
TOTAL	897,923	296	1.000	296	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 17. Neu et al. (1974) utilization-availability analysis using 270 unique nocturnal habitat utilization locations (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	105	0.351	95	0.389	0.314-0.464	Preferred	No
DOS	11,412	1	0.013	3	0.004	0-0.013	Avoided	No
EAB	1,127	8	0.001	0	0.030	0.003-0.056	Preferred	Yes
EEW	52,766	17	0.059	16	0.063	0.025-0.100	Preferred	No
EST	224,607	5	0.249	67	0.019	0-0.039	Avoided	Yes
LAC	20,064	1	0.022	6	0.004	0-0.013	Avoided	Yes
PAB	1,351	1	0.002	0	0.004	0-0.013	Preferred	No
PEW	26,184	110	0.029	8	0.407	0.331-0.483	Preferred	Yes
PAS	246,840	22	0.274	74	0.081	0.039-0.124	Avoided	Yes
TOTAL	900,246	270	1.000	270	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 18. Neu et al. (1974) utilization-availability analysis using 306 unique diurnal habitat utilization locations (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	129	0.445	136	0.422	0.350-0.493	Avoided	No
DOS	5,243	2	0.012	4	0.007	0-0.018	Avoided	No
EAB	480	3	0.001	0	0.010	0-0.024	Preferred	No
EEW	14,680	4	0.032	10	0.013	0-0.030	Avoided	Yes
EST	58,746	2	0.129	40	0.007	0-0.018	Avoided	Yes
LAC	5,903	5	0.013	4	0.016	0-0.035	Preferred	No
PAB	822	2	0.002	1	0.007	0-0.018	Preferred	No
PEW	10,105	129	0.022	7	0.422	0.350-0.493	Preferred	Yes
PAS	156,576	30	0.344	105	0.098	0.055-0.141	Avoided	Yes
TOTAL	454,658	306	1.000	306	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 19. Neu et al. (1974) utilization-availability analysis using 325 unique nocturnal habitat utilization locations (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	133	0.447	145	0.409	0.340-0.478	Avoided	No
EAB	480	2	0.001	0	0.006	0-0.017	Preferred	No
EEW	14,680	11	0.032	11	0.034	0.008-0.059	Preferred	No
EST	58,746	3	0.130	42	0.009	0-0.023	Avoided	Yes
LAC	5,903	6	0.013	4	0.018	0-0.037	Preferred	No
PAB	822	3	0.002	1	0.009	0-0.023	Preferred	No
PEW	10,105	134	0.022	7	0.412	0.343-0.482	Preferred	Yes
PAS	156,576	32	0.346	113	0.098	0.056-0.140	Avoided	Yes
UNS	2,521	1	0.006	2	0.003	0-0.011	Avoided	No
TOTAL	451,936	325	1.000	325	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 20. Neu et al. (1974) utilization-availability analysis using 1,065 locations during the non-hunting season (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	613	0.347	370	0.576	0.537-0.615	Preferred	Yes
DOS	11,412	1	0.013	13	0.001	0-0.003	Avoided	Yes
EAB	1,127	13	0.001	1	0.012	0.004-0.021	Preferred	Yes
EEW	52,766	27	0.058	62	0.025	0.013-0.038	Avoided	Yes
EST	224,607	5	0.247	263	0.005	0-0.010	Avoided	Yes
LAC	20,064	7	0.022	23	0.007	0-0.013	Avoided	Yes
PAB	1,351	6	0.001	2	0.006	0-0.012	Preferred	No
PEW	26,184	351	0.029	31	0.330	0.292-0.367	Preferred	Yes
PAS	246,840	41	0.271	289	0.038	0.023-0.054	Avoided	Yes
UNS	9,088	1	0.010	11	0.001	0-0.003	Avoided	Yes
TOTAL	909,334	1,065	1.000	1,065	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 21. Neu et al. (1974) utilization-availability analysis using 1,069 locations during the regular duck hunting season (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	510	0.356	381	0.477	0.440-0.515	Preferred	Yes
EAB	1,127	11	0.001	1	0.010	0.003-0.018	Preferred	Yes
EEW	52,766	35	0.059	64	0.033	0.019-0.046	Avoided	Yes
EST	224,607	3	0.253	271	0.003	0-0.007	Avoided	Yes
LAC	20,064	5	0.023	24	0.005	0-0.010	Avoided	Yes
PEW	26,184	469	0.030	32	0.439	0.402-0.476	Preferred	Yes
PAS	246,840	36	0.278	297	0.034	0.020-0.047	Avoided	Yes
TOTAL	887,484	1,069	1.000	1,069	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 22. Neu et al. (1974) utilization-availability analysis using 2,534 locations during non-hunting season (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	1,615	0.442	1,120	0.637	0.613-0.662	Preferred	Yes
DOS	5,243	3	0.011	29	0.001	0-0.003	Avoided	Yes
EAB	480	1	0.001	3	0.000	0-0.001	Avoided	No
EEW	14,680	6	0.032	81	0.002	0-0.005	Avoided	Yes
EST	58,746	4	0.128	326	0.002	0-0.004	Avoided	Yes
LAC	5,903	18	0.013	33	0.007	0.003-0.011	Avoided	Yes
PAB	822	7	0.002	5	0.003	0-0.005	Preferred	No
PEW	10,105	835	0.022	56	0.330	0.305-0.354	Preferred	Yes
PAS	156,576	44	0.342	868	0.017	0.011-0.024	Avoided	Yes
UNS	2,521	1	0.006	14	0.000	0-0.001	Avoided	Yes
TOTAL	457,179	2,534	1.000	2,534	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 23. Neu et al. (1974) utilization-availability analysis using 2,354 locations during regular duck season (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	1,068	0.450	1,059	0.454	0.428-0.479	Preferred	No
EAB	480	4	0.001	3	0.002	0-0.004	Preferred	No
EEW	14,680	26	0.033	77	0.011	0.006-0.016	Avoided	Yes
EST	58,746	3	0.131	308	0.001	0-0.003	Avoided	Yes
LAC	5,903	1	0.013	31	0.000	0-0.001	Avoided	Yes
PAB	822	2	0.002	4	0.001	0-0.002	Avoided	No
PEW	10,105	1,196	0.022	53	0.508	0.482-0.534	Preferred	Yes
PAS	156,576	54	0.348	820	0.023	0.015-0.031	Avoided	Yes
TOTAL	449,414	2,354	1.000	2,354	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 24. Neu et al. (1974) utilization-availability analysis using 250 locations during the non-hunting season (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	95	0.347	87	0.380	0.301-0.459	Preferred	No
DOS	11,412	1	0.013	3	0.004	0-0.014	Avoided	No
EAB	1,127	7	0.001	0	0.028	0.001-0.055	Preferred	No
EEW	52,766	13	0.058	15	0.052	0.016-0.088	Avoided	No
EST	224,607	4	0.247	62	0.016	0-0.036	Avoided	Yes
LAC	20,064	6	0.022	6	0.024	0-0.049	Preferred	No
PAB	1,351	3	0.001	0	0.012	0-0.030	Preferred	No
PEW	26,184	100	0.029	7	0.400	0.320-0.480	Preferred	Yes
PAS	246,840	20	0.271	68	0.080	0.036-0.124	Avoided	Yes
UNS	9,088	1	0.010	2	0.004	0-0.014	Avoided	No
TOTAL	909,334	250	1.000	250	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 25. Neu et al. (1974) utilization-availability analysis using 294 locations during regular duck season (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	116	0.356	105	0.395	0.325-0.464	Preferred	No
EAB	1,127	7	0.001	0	0.024	0.002-0.046	Preferred	Yes
EEW	52,766	19	0.059	17	0.065	0.029-0.100	Preferred	No
EST	224,607	3	0.253	74	0.010	0-0.025	Avoided	Yes
LAC	20,064	5	0.023	7	0.017	0-0.035	Avoided	No
PEW	26,184	122	0.030	9	0.415	0.345-0.485	Preferred	Yes
PAS	246,840	22	0.278	82	0.075	0.037-0.112	Avoided	Yes
TOTAL	887,484	294	1.000	294	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 26. Neu et al. (1974) utilization-availability analysis using 243 locations during the non-hunting season (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	104	0.442	107	0.428	0.346-0.510	Avoided	No
DOS	5,243	2	0.011	3	0.008	0-0.023	Avoided	No
EAB	480	1	0.001	0	0.004	0-0.015	Preferred	No
EEW	14,680	3	0.032	8	0.012	0-0.031	Avoided	Yes
EST	58,746	3	0.128	31	0.012	0-0.031	Avoided	Yes
LAC	5,903	8	0.013	3	0.033	0.003-0.062	Preferred	No
PAB	822	3	0.002	0	0.012	0-0.031	Preferred	No
PEW	10,105	98	0.022	5	0.403	0.322-0.484	Preferred	Yes
PAS	156,576	20	0.342	83	0.082	0.037-0.128	Avoided	Yes
UNS	2,521	1	0.006	1	0.004	0-0.015	Avoided	No
TOTAL	457,179	243	1.000	243	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 27. Neu et al. (1974) utilization-availability analysis using 323 locations during the regular duck season (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	134	0.450	145	0.415	0.346-0.483	Avoided	No
EAB	480	4	0.001	0	0.012	0-0.028	Preferred	No
EEW	14,680	10	0.033	11	0.031	0.007-0.055	Avoided	No
EST	58,746	3	0.131	42	0.009	0-0.023	Avoided	Yes
LAC	5,903	1	0.013	4	0.003	0-0.011	Avoided	Yes
PAB	822	1	0.002	1	0.003	0-0.011	Preferred	No
PEW	10,105	134	0.022	7	0.415	0.346-0.483	Preferred	Yes
PAS	156,576	36	0.348	113	0.111	0.068-0.155	Avoided	Yes
TOTAL	449,414	323	1.000	323	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Palustrine emergent wetlands were significantly preferred ($P \leq 0.10$) for both hunting and non-hunting periods for both years for both TOTAL and FREQ (**Tables 20–27**). In addition, I investigated differences in habitat use and availability for hunted and non-hunted habitats for each year using TOTAL (Tables 28–31) and FREQ (Tables 32–35). Estuarine aquatic bed habitat was preferred during 2002–03 using TOTAL ($P \leq 0.10$). For both years using both TOTAL and FREQ, pintails exhibited preference for cultivated habitats that were hunted, while non-hunted cultivated habitats were significantly avoided ($P \leq 0.10$). Palustrine emergent wetlands were again preferred significantly for each year for both hunted and non-hunted habitats for TOTAL and FREQ ($P \leq 0.10$). Estuarine aquatic bed habitats showed some degree of preference by pintails for both TOTAL and FREQ during both years (excluding hunted habitats in 2003–04 due to zero observations).

Palustrine emergent wetlands were preferred by pintails in all analyses ($P \leq 0.10$). Conversely, pintails avoided pasture habitats in all analyses ($P \leq 0.10$).

Movements

In 2002–03, 130 movements were recorded while 506 movements were recorded in the second year for a total of 636 movement measurements (Table 36). Mean distance moved per individual observation for 2002–03 was 3,849 m. Mean movement distance decreased to 2,553 m in 2003–04. The longest average movements were recorded in January (6,613 m) in 2002–03 and in February (3,471 m) during 2003–04.

A general northward trend in movements was observed both years of the study. Pintails settled in the rice prairies after a move from coastal areas and appeared to be highly associated with the distribution of managed wetlands, especially current and fallow rice fields and TPWP sites. Pintails tended to

Table 28. Neu et al. (1974) utilization-availability analysis using 1,557 locations in hunted habitats (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	999	0.347	541	0.642	0.610-0.673	Preferred	Yes
DOS	11,412	1	0.013	20	0.001	0-0.002	Avoided	Yes
EAB	1,127	20	0.001	2	0.013	0.005-0.020	Preferred	Yes
EEW	52,766	60	0.058	90	0.039	0.026-0.051	Avoided	Yes
EST	224,607	8	0.247	385	0.005	0-0.010	Avoided	Yes
LAC	20,064	11	0.022	34	0.007	0.002-0.013	Avoided	Yes
PAB	1,351	6	0.001	2	0.004	0-0.008	Preferred	No
PEW	26,184	374	0.029	45	0.240	0.212-0.268	Preferred	Yes
PAS	246,840	77	0.271	423	0.049	0.035-0.064	Avoided	Yes
UNS	9,088	1	0.010	16	0.001	0-0.002	Avoided	Yes
TOTAL	909,334	1,557	1.000	1,557	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 29. Neu et al. (1974) utilization-availability analysis using 577 locations in non-hunted habitats (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	124	0.759	438	0.215	0.175-0.255	Avoided	Yes
EAB	1,127	4	0.003	2	0.007	0-0.015	Preferred	No
EEW	52,766	2	0.127	73	0.003	0-0.009	Avoided	Yes
LAC	20,064	1	0.048	28	0.002	0-0.006	Avoided	Yes
PEW	26,184	446	0.063	36	0.773	0.732-0.814	Preferred	Yes
TOTAL	416,037	577	1.000	577	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 30. Neu et al. (1974) utilization-availability analysis using 3,276 locations in hunted habitats (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	2,425	0.443	1,450	0.740	0.721-0.760	Preferred	Yes
DOS	5,243	3	0.011	38	0.001	0-0.002	Avoided	Yes
EEW	14,680	31	0.032	105	0.009	0.005-0.014	Avoided	Yes
EST	58,746	7	0.129	421	0.002	0-0.004	Avoided	Yes
LAC	5,903	19	0.013	42	0.006	0.002-0.009	Avoided	Yes
PAB	822	9	0.002	6	0.003	0-0.005	Preferred	No
PEW	10,105	692	0.022	72	0.211	0.193-0.229	Preferred	Yes
PAS	156,576	89	0.343	1,123	0.027	0.020-0.034	Avoided	Yes
UNS	2,521	1	0.006	18	0.000	0-0.001	Avoided	Yes
TOTAL	456,699	3,276	1.000	3,276	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 31. Neu et al. (1974) utilization-availability analysis using 1,612 locations in non-hunted habitats (TOTAL) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	258	0.526	849	0.160	0.139-0.181	Avoided	Yes
EAB	480	5	0.001	2	0.003	0-0.006	Preferred	No
EEW	14,680	1	0.038	62	0.001	0-0.002	Avoided	Yes
PEW	10,105	1,339	0.026	42	0.831	0.809-0.852	Preferred	Yes
PAS	156,576	9	0.408	657	0.006	0.001-0.010	Avoided	Yes
TOTAL	383,944	1,612	1.000	1,612	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 32. Neu et al. (1974) utilization-availability analysis using 313 locations in hunted habitats (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,897	120	0.347	109	0.383	0.313-0.454	Preferred	No
DOS	11,412	1	0.013	4	0.003	0-0.011	Avoided	Yes
EAB	1,127	8	0.001	0	0.026	0.003-0.049	Preferred	Yes
EEW	52,766	27	0.058	18	0.086	0.045-0.127	Preferred	No
EST	224,607	7	0.247	77	0.022	0.001-0.044	Avoided	Yes
LAC	20,064	9	0.022	7	0.029	0.004-0.053	Preferred	No
PAB	1,351	3	0.001	0	0.010	0-0.024	Preferred	No
PEW	26,184	101	0.029	9	0.323	0.255-0.391	Preferred	Yes
PAS	246,840	36	0.271	85	0.115	0.069-0.161	Avoided	Yes
UNS	9,088	1	0.010	3	0.003	0-0.011	Avoided	No
TOTAL	909,334	313	1.000	313	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 33. Neu et al. (1974) utilization-availability analysis using 156 locations in non-hunted habitats (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2002–03.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	315,896.85	50	0.759	118.451	0.321	0.234-0.407	Avoided	Yes
EAB	1,126.62	2	0.003	0.422	0.013	0-0.034	Preferred	No
EEW	52,765.92	2	0.127	19.785	0.013	0-0.034	Avoided	Yes
LAC	20,063.88	1	0.048	7.523	0.006	0-0.021	Avoided	Yes
PEW	26,183.52	101	0.063	9.818	0.647	0.558-0.736	Preferred	Yes
TOTAL	416,036.79	156	1.000	156.000	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 34. Neu et al. (1974) utilization-availability analysis using 324 locations in hunted habitats (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	135	0.443	143	0.417	0.347-0.486	Avoided	No
DOS	5,243	2	0.011	4	0.006	0-0.017	Avoided	No
EEW	14,680	11	0.032	10	0.034	0.008-0.059	Preferred	No
EST	58,746	5	0.129	42	0.015	0-0.033	Avoided	Yes
LAC	5,903	9	0.013	4	0.028	0.005-0.051	Preferred	No
PAB	822	3	0.002	1	0.009	0-0.023	Preferred	No
PEW	10,105	111	0.022	7	0.343	0.276-0.410	Preferred	Yes
PAS	156,576	47	0.343	111	0.145	0.095-0.195	Avoided	Yes
UNS	2,521	1	0.006	2	0.003	0-0.011	Avoided	No
TOTAL	456,699	324	1.000	324	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 35. Neu et al. (1974) utilization-availability analysis using 223 locations in non-hunted habitats (FREQ) of female northern pintails wintering along the mid-coast of Texas during 2003–04.

C-CAP[1]	Available[2] (Ha)	Count[3]	AHAT[4]	Expected[5] (Ha)	PHAT[6]	90% C.I.[7]	Preference	Significant
CUL	202,103	82	0.526	117	0.368	0.293-0.443	Avoided	Yes
EAB	480	5	0.001	0	0.022	0-0.045	Preferred	No
EEW	14,680	1	0.038	9	0.004	0-0.015	Avoided	Yes
PEW	10,105	130	0.026	6	0.583	0.506-0.660	Preferred	Yes
PAS	156,576	5	0.408	91	0.022	0-0.045	Avoided	Yes
TOTAL	383,944	223	1.000	223	1.000			

C-CAP[1] CLASSES: CUL = Cultivated, DOS = Developed Open Space, EAB = Estuarine Aquatic Bed, EEW = Estuarine Emergent Wetland, EST = Estuarine Subtidal, LAC = Lacustrine, PAB = Palustrine Aquatic Bed, PAS = Pasture, PEW = Palustrine Emergent Wetland, UNS = Unconsolidated Shore

Available[2]: Available Habitat (Ha)

Count[3]: # observations

AHAT[4]: class proportion

Expected[5]: expected # observations

PHAT[6]: proportion of observations in each class

90% C.I.[7]: Bonferroni 90% confidence interval for proportion of occurrence

Table 36. Movement distances for female northern pintails wintering along the Texas mid-coast during 2002–03 and 2003–04.

	2002–03					2003–04					
Month	*n*	Mean (m)	StDEV (m)	Min (m)	Max (m)	Month	*n*	Mean (m)	StDEV (m)	Min (m)	Max (m)
November	3	500	465	0	919	November	3	740	1,281	0	2,220
December	15	1,250	1,727	0	5,914	December	180	2,241	3,367	0	20,358
January	10	6,613	10,270	0	34,790	January	168	2,499	5,502	0	43,791
February	60	2,837	3,102	0	14,270	February	112	3,471	8,888	0	67,639
March	42	5,804	13,923	125	58,311	March	42	1,799	2,520	0	8,235
April	0	N/A	N/A	N/A	N/A	April	1	356	N/A	356	356
TOTAL	130	3,849	8,778	0	58,311	TOTAL	506	2,553	6,798	0	67,639

frequent areas that had numerous flooded wetlands within a short distance of one another, tending to avoid isolated wetlands. These concentrated wetland areas were often used by radio-tagged pintails each year of the study, providing proper water levels were available (e.g., some wetlands were pumped too deep by managers, prohibiting adequate foraging conditions). Diurnal and nocturnal use of hunted lands increased following the close of the general duck season each year (Table 37). Of the rice prairies west of Houston, Garwood and Lissie Prairies appear to be the most used by pintails within the 95% Kernel core area.

Interregional Movements

Only 2 female pintails emigrating from the PLR study area (Moon 2004) were recorded on my study area. Both were detected along the mid-Coast of Texas during the first year, with the first female located on 20 December 2002 and staying in the study area through 13 March 2003 (20 locations: 8 Garwood Prairie, 12 Calhoun County). The other female appeared on 31 December 2002 and remained through 10 February 2003 (4 locations: Calhoun County). During 2003–04, one PLR pintail was shot in Wharton County; however, no habitat use locations were estimated for it or any other PLR pintail during the second year. Because the 24 PLR pintail locations were within our 95% Kernel estimate for 2002–03, they were included in the analysis. No pintails from our study were recorded in the PLR during the 2 years.

Residency and Departure Times

During 2003, 18% of radio-tagged pintails departed from the study area during 13 February to 2 March. Another 30% departed the area from 2 March to 22 March. Approximately 50% (47 of 95 pintails) of radiotagged pintails were still detected within the primary study area on 6 March. In 2004, approximately 76% of radiotagged pintails were still within the primary study area on 21 March, with

Table 37. Female northern pintail habitat use locations (buffered) within Texas Prairie Wetland Projects (TPWP) as a percentage of total habitat availability within the combined 95% Kernel by month for 2002–03 and 2003–04.

Month	Locations within TPWP	Total Locations	% of Total
October 2002	0	17	0.00
November 2002	7	100	7.00
December 2002	37	650	5.69
January 2003	62	609	10.18
February 2003	34	451	7.54
March 2003	13	273	4.76
April 2003	1	34	2.94
TOTAL Year 1	154	2,134	7.22
November 2003	0	128	0.00
December 2003	55	1,501	3.66
January 2004	61	1,209	5.05
February 2004	45	1,125	4.00
March 2004	132	827	15.96
April 2004	27	98	27.55
TOTAL Year 2	320	4,888	6.55
GRAND TOTAL	474	7,022	6.75

the number declining to approximately 25% on 25 March. Mean departure date for the first year was 6 March, while the mean departure date occurred approximately 2 weeks later on 23 March during 2004.

Texas Prairie Wetlands Projects

Using the 95% Fixed Kernel, TPWP sites accounted for only 3,887 ha, or 0.4% and 0.8% of the 2002–03 and 2003–04 total availability, respectively. Combined overall use of TPWP sites accounted for 474 of the 7,022 locations (6.8%; Table 38). Some individual female pintails use of TPWP sites was considerably higher. Use of TPWP sites during the first year accounted for 154 of 2,134 locations (7.2%), with the highest use of TPWP sites occurring during January (10.2%). Of the 154 locations in TPWP sites, 89 (57.8%) occurred during the general duck season. In 2003–04, overall use of TPWPs decreased slightly to 6.6% (320 of 4,888 locations) compared to 2002–03. Of these, 28.4% (91 locations) were collected during the regular duck season. However, I noted large-scale habitat loss throughout the Texas mid-coast as a result of landowners/managers releasing water during the last week of the waterfowl season in 2004 (12–18 Jan.). As a result, TPWP use increased to 15.96% in March (132 of 827 locations) and to 27.55% in April (27 of 98 locations). This coincided with a drop in survival during February and March during the second year (Chapter I).

Table 38. Diel habitat utilization of female northern pintails for hunted and non-hunted lands during the regular duck season and no season time periods in 2002–03 and 2003–04 along the mid-coast of Texas.

		Duck Season		No Season	
Year	Land Use	Diurnal	Nocturnal	Diurnal	Nocturnal
2002–03	Non-hunted	31.17%	34.12%	14.63%	20.07%
	Hunted	65.83%	65.88%	85.37%	79.93%
2003–04	Non-hunted	53.34%	49.13%	11.03%	21.38%
	Hunted	46.66%	50.87%	88.97%	78.62%

DISCUSSION

Rice agriculture and palustrine emergent wetlands appear to be preferred habitats for pintails wintering along the mid-coast of Texas, both of which have shown marked declines in the region during the past 3 decades (Moulton et al. 1997). Within the C-CAP cultivated class, rice agriculture (both fallow rice and current rice) had the highest use during both 2002–03 (1,097 locations; 97.7%) and 2003–04 (2,512 locations; 93.6%). Of total rice agriculture locations, use of current rice was similar for each year at about 35% and fallow rice was about 65%. Palustrine emergent wetlands were preferred by pintails in all analyses. Most palustrine emergent wetlands were either rice agriculture, managed freshwater wetlands (e.g., TPWP sites), or naturally occurring depressional wetlands. Diurnal and nocturnal use of hunted lands during the non-hunting periods increased each year, many of which were cultivated and palustrine emergent wetlands. Periods of intense hunting pressure and disturbance were most the likely causes of deterring pintails from hunted lands during the general duck season.

Other habitats were used less by pintails. The remaining habitat use locations in cultivated habitat (not including rice rotation) ranged from 2.3–6.4% of the cultivated total, including grain sorghum (milo), crayfish (*Procambarus clarkii*) operations, winter wheat, and disked fields (e.g., usually sheet water observed in disked milo, soybeans, and cotton). For example, non-hunted cultivated habitats were probably avoided because they were not being managed (i.e., flooded) and I saw no instances of dry field feeding by pintails in my study area. Estuarine aquatic bed and estuarine emergent wetlands appeared to be the most utilized of the estuarine habitat. A small sample of pintails (n = 11) captured at Peach Point WMA in 2002 accounted for the majority of use of the estuarine aquatic bed and estuarine emergent wetlands during the first year. Estuarine aquatic bed wetlands dominated by wigeongrass (*Ruppia maritimia*) were used by pintails at Peach Point Wildlife Management Area. However, pintails left Peach Point Wildlife Management Area immediately after the youth hunt in October. Estuarine subtidal habitats were avoided by female pintails. Non-cultivated lacustrine habitats also had minimal use, as they were typically deep freshwater industrial impoundments. Pintail locations in lacustrine habitat tended to occur in large goose roosts (Cowardin et al. 1979).

Pasture habitats were avoided in all analyses ($P \leq 0.1$), and only accounted for 2.0–3.6% of the total use. The avoidance of pasture can be partly explained by the large amount of pasture available and discrepancies in the C-CAP classification of pasture. In addition, what I classified as fallow rice agriculture in the field may be pasture (e.g., the field may still have been or not have been in rice rotation at the time). Pintails observed in pasture were most often located in palustrine emergent depressional wetlands within the pasture that were classified as such. Additionally, pintails were observed foraging in sheet water in pasture habitats following rain events. The largest flock of pintails (estimated 12,000 pintails) I recorded during late-winter was observed taking advantage of the sheet water conditions in a pasture in southern Garwood Prairie. Sheet water habitats are typically short-duration events and I may not have been able to adequately assess their utilization given my sampling schedule.

Pintails were observed foraging in wetlands (e.g., sheet water occurring in pasture) following grubbing and foraging activities of greater white-fronted (*Anser albifrons*) and lesser snow geese. Foraging activity by the geese appears to benefit pintails in landscapes that otherwise might have vegetation too dense to allow normal access by pintails.

Similar to other wintering pintail research, pintails wintering along the mid-coast of Texas appear to exhibit a strong preference for rice agriculture. Preference for rice agriculture has also been documented for pintails wintering in the Sacramento Valley of California (Miller 1987) and southwestern Louisiana (Cox and Afton 1997). Cox and Afton (1997) noted in particular that pintails used rice fields at night. I observed large flocks of pintails making evening foraging flights to second-crop rice fields (either standing crop or harvested) in late October through early November and smaller flocks to harvested rice fields the remainder of each year. Some pintails (based on movement data) did not move from rice habitats, or made very small flights from one end of a field to another.

In addition to the declines in waterfowl habitat, light goose populations have also shown declines in Texas (USFWS 1999). Radio-tagged pintails were observed frequently using habitats set aside as goose roosts, similar to observations by Anderson (1994). In addition, other smaller roost (or refuge) sites managed for waterfowl use were used by pintails. These wetlands appeared to play a greater role during periods of intense hunting disturbance by providing sites for resting. These sites may be particularly important because they were some of the few sites that retained water after the close of the duck season because of the light goose conservation order. Waterfowl managers should be concerned if the portion of the waterfowl hunting industry in Texas that is supported by light goose hunting is adversely effected by reductions in light goose numbers, because it may result in a decline in roost habitats that are managed specifically for geese yet appear to be important to pintails.

It appears that large-scale drainage during the last week of duck season in late January of wetlands managed for waterfowl hunting is a common practice in the RP region of Texas, which is exacerbated during drought conditions. TPWP sites appeared to have high use relative to their availability on the landscape, especially in late-winter. Efforts by managers to retain water longer (e.g., through the end of April) in wetlands such as TPWP sites should be enacted as pintails are apparently staying longer than previous accounts on the wintering grounds along the Texas Coast. Currently, TPWP sites that are to be planted are drained around 1 March and those not in production are under contract to hold water in the TPWP until 1 April (Chad Manlove, Ducks Unlimited, personal communication). Additionally, longer retention of water in managed wetlands along the Texas Coast may benefit breeding mottled ducks (Finger 2002). Wintering pintails may rely more on managed sites like the TPWP in the future as rice agriculture and high-quality palustrine wetlands decline even further. Also, if pintails are heavily using hunted lands during the non-hunting period, large-scale drainage of these habitats in late January may lead to reduced foraging opportunities for pintails preparing to migrate from the Texas Coast.

Weather also may have played a role in habitat use and movements during the study. Effects of Hurricane Claudette in 2003 (e.g., altered salinity levels and structure of barrier islands along the mid-coast) may have influenced habitat in Calhoun County, as fewer radio-tagged birds left MFW-ANWR for the adjacent depressional emergent wetlands and estuaries to the south. A noted vegetative response to the wet conditions in 2002–03 may have indirectly influenced use and movements, limiting movements to more open habitats (e.g., managed) wetlands as many of the natural coastal wetlands used the previous year were covered in thick stands of rattlebox (*Sesbania* sp.).

Future GIS analyses are needed to provide a better indication of habitat availability for pintails along the mid-coast of Texas. TPWP sites were included in the analysis as a potential indicator of freshwater availability (managed freshwater in particular) within the mid-coast of Texas. The large-scale habitat loss following the general duck season in 2004 resulted in increased TPWP use by pintails (16% to 28% for March and April, respectively; some individuals with considerably higher use of TPWP sites), suggesting that late winter-spring habitat availability may be a limiting factor for pintails wintering in the mid-coast of Texas. Future remote sensing research using surface water extraction (using Landsat 5 imagery from 2–3 scenes during each year of the study) and GIS software applications may be beneficial in better defining habitat availability and in documenting habitat losses following the waterfowl season or in times of drought. Using imagery soley does not work well to detect rice rotation habitat. Ancillary data needs to be combined in a GIS environment to improve classification of ricefields, palustrine depressional wetlands within rice rotation and pasture habitats, and ephemeral wetland habitat (e.g., sheet water). Future C-CAP reclassification needs to be done to address the problem of detecting palustrine emergent depressional wetlands within the cultivated class.

Pintail movements appeared to be associated with large wetland complexes within the study area. In late-winter, food depletion in these areas of high waterfowl use may have attributed to the maximum movements being recorded during January and February. For example, the palustrine flooded habitat deficit in the Texas mid-coast increases from 3,100 ha in early-season to 33,000 ha for late season habitat (M. Brasher, GCJV, personal communication).

Diurnal and nocturnal use of hunted lands increased following the close of the general duck season each year, and this may have also attributed to the longer distances observed following the general duck season as resources were depleted and wetlands were drained.

In 2002–03, 79% of the available sample of radioed pintails remained on the Texas Gulf Coast wintering sites when all birds from the PLR study had departed to breeding areas (Moon 2004). Similarly, pintails remained much longer along the Texas Gulf Coast than compared to the PLR birds during the second year. Of the available sample, 82% of radioed pintails were still within the study area on 1 March when all tagged pintails in the PLR had departed (Moon 2004). My available sample of radiotagged pintails within the study area declined from 76% to 25% from 21 March to 25 March 2004.

CGJV migration chronology for the Texas mid-coast Initiative area indicates the departure date for pintails to be late February (Wilson and Esslinger 2002); however, findings from my tagged sample suggest that pintails are spending longer amounts of time on the wintering grounds. Ballard et al. 2006 suggested that later departure in spring by pintails may have negative consequences on their fitness. Benefits of early arrival on breeding grounds and subsequent timing of breeding events are apparent as reproductive success is inversely related to date of egg laying in many migratory species (Flint and Grand 1996, Guyn and Clark 2000). Waterfowl that are able to initiate nests early experience greater nest success with larger clutches (Krapu 1981). Further, brood survival tends to be greater for earlier hatched nests due to declines in seasonal wetland availability and food resources.

Habitat quantity and quality along the Texas Coast wintering areas may play a larger role than expected in allowing pintails to optimize migration and timing of arrival on breeding grounds. In addition, increased foraging demand during late-winter may have negative consequences on pintails prior to departure. Foraging habitat needs for waterfowl wintering on the Texas mid-coast were estimated using assumptions of the energetic demands of ducks, caloric values of seeds, and the farming practices in the area (Wilson and Esslinger 2002). Current estimates reveal that the foraging supply is approximately half that needed to meet the demand for wintering waterfowl in the GCJV Texas Mid-Coast Initiative Area during late winter (33,000 and 66,500 hectares for supply and demand, respectively) (M. Brasher, GCJV, unpublished data). Further, the current foraging supply for late-season palustrine flooded habitat (33,000 hectares) is over ten-fold the deficit for early-season palustrine flooded habitat (3,100 hectares; M. Brasher, GCJV, unpublished data), underscoring the need for habitats that are managed for waterfowl during late winter in this region.

MANAGEMENT IMPLICATIONS

Sound recommendations of any research project are fundamental to habitat management and refuge establishment. An effective habitat management plan for pintails and its implementation by federal and state agencies and private conservation organizations is needed along the Texas mid-coast. Increasing amounts of high-quality palustrine wetland habitat along the mid-coast to meet and surpass GCJV habitat objectives via programs such as the TPWP is critical to mitigate the continued loss of habitat in the region. In addition, the mid-coast of Texas is lacking in state and federal managed refuge areas for waterfowl. As wetland habitat is further degraded along the Texas coast, the existing wetlands may be experience increased bird use. Where larger refuge sites do exist, they are primarily coastal marsh and estuarine habitats with submergent grass beds, both of which had minimal use by radiotagged pintails in this study. In addition, 2007 estimates of wintering waterfowl habitat reveal over 93,000 hectares of surplus coastal marsh habitat (fresh, intermediate, and brackish marsh; Michael Brasher, GCJV, unpublished data, GCJV Texas Mid-Coast Initiative Area). Refuge systems have been very successful in improving habitat for migratory waterfowl and other wetland dependant species across North America. Currently, goose roost habitats are serving as an important mini-refuge “complex” (Cox and Afton 1998b) along the mid-coast of Texas. If the light goose hunting industry along the Texas mid-coast experiences a downfall, many goose roost habitats that are currently serving as refuges for pintails and other waterfowl may be lost.

Adequate foraging habitat for pintails should also be addressed. Current estimates in the GCJV Texas Mid-Coast Initiative Area of wintering waterfowl foraging habitat reveal a deficit ranging from 3,100–33,000 hectares for flooded palustrine habitat throughout winter (Michael Brasher, GCJV, unpublished data). Foraging deficits for the Texas mid-coast account for 25.5% of the early- and 62.5% of the late-flooded palustrine habitat deficits for the entire Texas coast (Michael Brasher, GCJV, unpublished data). The addition of high-quality, shallowly flooded palustrine wetlands in the mid-coast of Texas should benefit pintails wintering in the region, as they appeared to exhibit a preference for these sites.

Palustrine emergent wetlands were shown to play an important role for pintails wintering along the Texas mid-coast during my study; however, they are the most threatened wetland type in this area (Moulton et al. 1997). Approximately 30% of the Texas Gulf Prairies and Marshes were once freshwater wetlands that supported emergent vegetation, frequently referred to as prairie potholes (Moulton et al. 1997). Many of these potholes have been lost or degraded due to development and agricultural land-leveling, and even fewer pothole “complexes” exist today (Moulton et al. 1997). Habitat management for pintails along the Texas mid-coast should focus on delivery and maintenance of high-quality palustrine wetland projects. In addition, partnership agreements with landowners for new projects (e.g., TPWPs) should require landowners to set aside units for refuge purposes, similar to the “mini-refuges” described by Cox and Afton (1998b) in southwest Louisiana. For example, landowners entering multiple projects into an agreement could designate 1 as refuge or non-hunted for a season (e.g., rotate the refuge site annually or designate one project per landowner for refuge establishment) or for the length of the agreement. A similar approach is currently being used by the Katy Prairie Conservancy (KPC) where KPC allows hunting on one-half of its preserves. Also, agreements need to address water level maintenance, as I experienced several sites that held water too deep for pintails to adequately forage. An effort should be made to further educate landowners about water level management needed for optimal foraging conditions for waterfowl. In addition, many sites were drained early following the close of the regular duck season. Routine management of these sites is important in habitat restoration and enhancement efforts (Wilson and Esslinger 2002), and compliance (and enforcement) of agreements should be a high priority. Additional incentives could be offered to landowners willing to hold additional water during late-winter and spring. Government subsidy programs for landowners impounding water during winter could also be beneficial in attracting more landowners to the conservation effort, or a Conservation Reserve Program (CRP) type approach specifically geared toward increasing palustrine habitat along the Texas mid-coast.

I noted many fields that were either fallow rice that had been several years out of production or old rice fields that had converted to pasture. Many of these sites had working or existing contour levees that could be managed to trap and pool rainfall for waterfowl in the winter. In addition, many dry fields could provide habitat by closing off their water control structures and holding runoff from rain events. With up to 80% of rice rotation fields out of production at a given time (Wilson and Esslinger 2002) and the abundance of fallow fields out of production, there is potential to provide additional habitat for wintering pintails. However, invasive Chinese tallow trees are creating “tallow forests” that offer little value for wildlife, especially waterfowl, at many sites along the Texas coast. Landowner programs such as the Texas R.I.C.E. (Texas Rice Industry Coalition for the Environment), Arkansas’ R.I.C.E. (Rice Industry Caring for the Environment) Project, and Operation Quackback in Louisiana are effective educational programs that give participants a collective, proactive stake in enhancement of their rice resource for the benefit of waterfowl, water quality, and the environment in general. In addition, education programs for landowners that focus on new venture opportunities such as bird watching might be helpful in recruiting additional landowners to provide waterfowl habitat during winter. A designated "broker" might also be influential in linking the supply and demand of hunting and eco-tourism opportunity in the region. Also, an easement program similar to work done by the KPC needs to be enacted on a large-scale for the Lissie and Garwood prairies, as they appeared to be important wintering areas for pintails, to deter the westward encroachment of the Houston metropolitan area. A new, similar initiative along the Texas mid-coast that focuses not only on the benefits of water impoundment but also addresses the management of invasive species such as Chinese tallow and MacCartney Rose would benefit pintails and other wetland dependant wildlife.

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APPENDIX A.

APPENDIX A. Measurement data of adult and juvenile female northern pintails captured during 2002–03 along the mid-coast of Texas.

DATE	FREQ	AGE[1]	AREA[2]	MASS[3] (g)	WING CHORD (mm)	CULMEN (mm)	TARSUS (mm)	MIDDLE TOE (mm)	HEAD LENGTH (mm)
10/21/2002	5.873	HY	GC	710	232	47.23	47.67	49.65	98.92
10/21/2002	5.853	AHY	GC	810	253	49.05	52.46	52.90	99.09
10/21/2002	5.602	AHY	GC	770	263	46.14	49.12	50.03	99.75
10/21/2002	5.621	AHY	GC	790	258	50.55	50.54	51.60	103.60
10/21/2002	5.832	HY	GC	750	250	48.22	49.58	49.81	99.43
10/21/2002	5.527	AHY	GC	730	248	47.38	51.74	52.13	100.04
10/21/2002	5.517	HY	GC	670	243	47.32	49.82	50.15	99.49
10/21/2002	5.506	HY	GC	660	247	41.39	48.68	47.95	93.57
10/21/2002	6.573	AHY	GC	730	247	47.88	52.93	51.89	101.53
10/21/2002	6.582	AHY	GC	800	245	46.16	51.03	48.99	100.00
10/21/2002	6.621	AHY	GC	780	235	45.15	48.67	51.22	99.32
11/13/2002	6.802	HY	GC	865	256	47.75	51.77	50.70	101.81
11/13/2002	6.925	HY	GC	785	243	48.03	50.05	51.89	101.89
11/13/2002	6.944	HY	GC	570	244	48.86	54.21	50.17	102.80
11/13/2002	6.916	HY	GC	850	246	48.42	50.45	50.43	101.83
11/13/2002	6.820	HY	GC	705	245	49.75	51.45	50.36	101.29
11/13/2002	6.850	HY	GC	660	251	44.67	47.88	48.30	96.38
11/13/2002	6.982	AHY	GC	820	249	46.42	51.95	50.30	98.37
11/21/2002	5.914	HY	GC	820	234	48.02	49.80	48.74	100.77
11/21/2002	6.752	HY	GC	570	251	44.93	46.47	45.51	95.51
11/21/2002	6.702	HY	GC	840	248	47.33	50.45	49.39	97.58
11/21/2002	6.772	HY	GC	810	248	45.30	50.13	50.08	97.85
11/21/2002	6.990	HY	GC	690	242	45.96	49.98	48.00	97.84
11/21/2002	6.051	AHY	GC	880	253	45.57	55.18	45.97	97.07
11/21/2002	6.522	HY	GC	880	251	47.70	50.24	45.84	100.70
11/21/2002	5.672	AHY	GC	680	236	44.02	51.58	49.66	99.43
11/21/2002	6.012	AHY	GC	850	257	47.08	49.54	48.27	100.76
11/21/2002	6.061	HY	GC	690	239	45.97	48.74	46.15	97.32
11/21/2002	5.713	HY	GC	820	250	47.40	50.84	46.57	99.31
11/21/2002	6.182	HY	GC	725	238	50.53	53.43	52.07	104.08
11/21/2002	6.237	AHY	GC	750	249	47.28	51.94	47.93	98.78
11/21/2002	6.124	AHY	GC	900	258	45.88	51.20	48.20	94.75

AGE[1]: AHY = after hatch-year; HY = hatch year

AREA[2]: GC = gulf coast; RP = rice prairie; MASS[3]: body mass at capture minus estimated weight of rice in upper digestive tract

APPENDIX A. Continued.

DATE	FREQ	AGE[1]	AREA[2]	MASS[3] (g)	WING CHORD (mm)	CULMEN (mm)	TARSUS (mm)	MIDDLE TOE (mm)	HEAD LENGTH (mm)
11/21/2002	5.557	AHY	GC	930	248	45.55	52.04	52.11	99.55
11/21/2002	5.939	HY	GC	750	248	46.33	52.75	51.46	101.29
11/21/2002	5.420	HY	GC	780	250	48.54	47.74	46.91	102.06
11/21/2002	5.271	AHY	GC	810	248	45.18	46.71	49.16	99.22
11/21/2002	5.813	HY	GC	780	242	48.64	52.38	48.06	102.86
11/21/2002	4.169	AHY	GC	790	258	47.13	49.56	48.74	99.31
11/21/2002	6.780	HY	GC	730	240	43.79	47.77	49.34	94.54
11/21/2002	5.766	HY	GC	700	246	46.93	48.88	47.35	99.39
11/21/2002	4.888	HY	GC	810	240	46.17	51.16	49.41	98.54
11/21/2002	4.295	AHY	GC	710	253	46.42	51.31	49.28	101.27
11/21/2002	7.982	HY	GC	760	237	45.19	50.39	48.98	99.18
11/21/2002	7.959	AHY	GC	840	248	48.82	50.67	49.47	101.40
11/21/2002	7.991	AHY	GC	910	255	45.39	49.64	49.98	98.48
11/21/2002	7.952	HY	GC	840	235	49.04	51.44	49.10	100.50
11/21/2002	7.181	AHY	GC	800	250	46.18	51.49	45.57	100.15
11/21/2002	7.941	AHY	GC	960	255	45.89	52.02	50.37	99.57
11/21/2002	7.931	AHY	GC	750	254	47.54	51.35	49.07	98.73
11/21/2002	7.173	AHY	GC	800	251	43.70	53.08	47.25	97.63
11/21/2002	7.162	AHY	GC	930	248	46.33	50.55	46.66	101.87
11/21/2002	7.002	HY	GC	680	238	40.38	47.94	46.01	93.36
11/21/2002	7.472	HY	GC	640	244	44.97	50.94	49.05	98.01
11/21/2002	7.592	HY	GC	720	241	47.20	49.66	45.15	99.98
11/21/2002	7.502	AHY	GC	760	246	45.09	51.05	47.45	97.23
11/21/2002	7.441	HY	GC	730	235	45.94	49.40	43.63	99.21
11/21/2002	7.602	HY	GC	860	252	45.95	52.09	46.62	98.24
11/21/2002	7.822	HY	GC	740	232	48.72	52.31	45.66	101.49
11/21/2002	7.121	AHY	GC	950	238	50.40	63.00	47.36	103.78
11/21/2002	7.261	HY	GC	710	239	47.14	49.35	46.40	99.49
11/21/2002	7.902	AHY	GC	690	240	47.37	51.24	47.75	99.07
11/21/2002	7.341	HY	GC	780	248	47.76	52.12	47.07	102.00
11/21/2002	7.712	AHY	GC	940	241	45.24	49.06	45.07	97.79
11/21/2002	7.482	AHY	GC	820	255	46.71	50.92	48.27	100.01
11/21/2002	7.870	AHY	GC	840	246	47.84	49.85	46.02	99.17
11/21/2002	7.751	AHY	GC	690	231	43.13	48.88	44.50	93.14
11/21/2002	7.690	AHY	GC	770	244	45.74	52.18	47.46	97.95
11/21/2002	7.852	HY	GC	705	237	44.35	49.48	46.18	96.65
11/21/2002	7.231	HY	GC	765	245	46.99	50.67	45.92	99.37

AGE[1]: AHY = after hatch-year; HY = hatch year

AREA[2]: GC = gulf coast; RP = rice prairie; MASS[3]: body mass at capture minus estimated weight of rice in upper digestive tract

APPENDIX A. Continued.

DATE	FREQ	AGE[1]	AREA[2]	MASS[3] (g)	WING CHORD (mm)	CULMEN (mm)	TARSUS (mm)	MIDDLE TOE (mm)	HEAD LENGTH (mm)
11/21/2002	7.581	HY	GC	680	241	45.38	50.65	44.02	99.67
11/21/2002	7.540	HY	GC	755	247	46.62	50.33	45.52	100.61
11/21/2002	7.432	AHY	GC	850	262	46.92	51.62	47.14	102.06
11/21/2002	7.512	AHY	GC	880	252	44.83	51.15	48.07	97.72
11/21/2002	7.571	HY	GC	755	252	47.16	51.32	46.15	100.18
11/21/2002	7.292	HY	GC	835	249	49.26	51.46	47.25	102.78
11/21/2002	7.611	AHY	GC	830	260	47.03	54.42	49.15	100.09
11/21/2002	7.832	HY	GC	715	237	42.72	49.41	43.60	95.07
11/21/2002	7.661	AHY	GC	850	253	47.34	52.89	50.40	102.53
11/21/2002	7.201	HY	GC	750	252	47.25	51.94	47.27	100.65
11/21/2002	7.721	AHY	GC	790	245	43.71	47.76	44.72	94.35
11/21/2002	7.911	HY	GC	630	244	44.95	51.08	45.15	97.72
11/21/2002	7.270	HY	GC	795	249	47.08	49.95	46.46	100.53
11/21/2002	7.421	HY	GC	710	242	47.72	51.10	46.40	100.76
11/21/2002	7.052	HY	GC	720	248	45.34	49.50	45.09	99.50
11/21/2002	7.670	AHY	GC	740	246	47.63	51.27	45.93	102.70
11/21/2002	7.771	AHY	GC	730	246	44.72	49.15	46.08	97.60
11/21/2002	7.301	AHY	GC	840	251	47.45	48.86	45.11	98.60
11/21/2002	7.249	AHY	GC	790	262	46.07	52.45	46.94	99.10
11/21/2002	7.780	HY	GC	755	248	44.15	52.11	44.65	95.80
11/21/2002	7.390	AHY	GC	805	248	45.68	48.92	44.32	98.60
11/21/2002	7.450	AHY	GC	800	266	46.77	56.33	50.81	100.40
11/21/2002	7.681	HY	GC	810	256	46.04	49.34	46.34	96.10
11/21/2002	7.321	AHY	GC	900	254	48.49	52.69	47.41	101.80
11/21/2002	7.860	HY	GC	755	249	46.88	50.73	46.66	101.23
11/21/2002	7.462	AHY	GC	800	260	48.55	52.34	47.51	102.42
11/21/2002	7.642	AHY	GC	815	261	47.08	53.14	48.19	101.01
11/21/2002	7.622	AHY	GC	795	255	43.56	50.62	44.80	97.39
11/21/2002	7.212	AHY	GC	835	256	46.42	52.15	47.57	100.69
11/21/2002	7.331	AHY	GC	890	254	49.30	52.30	46.24	103.35
11/21/2002	7.492	HY	GC	875	245	46.33	51.56	47.54	101.26
11/21/2002	7.892	HY	GC	650	239	45.37	52.52	47.15	98.55
11/21/2002	7.531	HY	GC	815	254	47.71	52.80	49.20	102.47
11/21/2002	7.550	HY	GC	760	245	47.83	50.94	45.15	102.29
11/21/2002	7.522	AHY	GC	810	252	49.72	53.87	48.12	103.41
11/21/2002	7.082	HY	GC	900	258	48.66	52.00	46.68	100.52
11/21/2002	7.801	HY	GC	805	247	50.49	52.25	45.96	101.80

AGE[1]: AHY = after hatch-year; HY = hatch year

AREA[2]: GC = gulf coast; RP = rice prairie; MASS[3]: body mass at capture minus estimated weight of rice in upper digestive tract

APPENDIX A. Continued.

DATE	FREQ	AGE[1]	AREA[2]	MASS[3] (g)	WING CHORD (mm)	CULMEN (mm)	TARSUS (mm)	MIDDLE TOE (mm)	HEAD LENGTH (mm)
11/21/2002	7.631	HY	GC	690	253	49.25	51.11	48.40	102.67
11/21/2002	7.221	AHY	GC	770	252	45.19	51.87	48.77	101.32
11/21/2002	7.652	HY	GC	810	240	46.75	52.34	47.74	99.16
11/21/2002	7.701	HY	GC	705	247	47.27	50.35	46.49	100.58
11/21/2002	7.073	HY	GC	640	230	43.82	50.32	44.73	97.19
11/21/2002	7.241	HY	GC	790	251	47.07	49.46	46.22	99.81
11/21/2002	7.792	HY	GC	830	256	47.68	50.16	46.08	100.55
11/21/2002	7.842	HY	GC	695	250	44.97	53.10	48.32	99.46
11/21/2002	7.399	HY	GC	695	236	42.51	50.47	46.81	94.91
11/21/2002	7.410	HY	GC	635	240	43.76	49.77	45.43	99.00
11/21/2002	7.381	HY	GC	790	253	43.91	51.33	47.09	97.97
11/21/2002	7.762	AHY	GC	730	247	46.17	52.18	46.45	98.43
11/21/2002	7.370	HY	GC	700	244	45.20	52.46	47.38	99.56
11/21/2002	7.361	HY	GC	820	247	45.67	52.86	47.68	99.04
11/21/2002	7.192	AHY	GC	810	252	46.54	48.83	44.72	99.16
11/21/2002	7.812	AHY	GC	760	252	48.89	52.61	46.76	101.76
11/21/2002	7.280	HY	GC	710	237	47.25	49.10	44.56	100.40
11/21/2002	7.880	AHY	GC	640	246	44.21	51.19	46.84	92.98
11/21/2002	7.352	HY	GC	780	251	48.77	54.44	49.37	103.06
11/21/2002	7.923	HY	GC	760	242	46.54	51.20	44.89	100.13
11/21/2002	7.731	HY	GC	790	247	46.93	50.64	47.44	100.88
11/21/2002	7.309	AHY	GC	770	240	47.42	48.79	44.35	97.91
11/21/2002	7.102	AHY	GC	830	252	47.54	52.10	44.98	99.77
11/21/2002	6.874	HY	GC	790	250	48.12	51.43	47.88	102.28
11/21/2002	5.292	HY	GC	750	249	49.34	51.60	47.86	99.87
11/21/2002	6.837	HY	GC	750	247	43.10	50.76	44.63	97.54
11/21/2002	6.954	AHY	GC	640	248	41.56	47.40	42.51	93.15
11/21/2002	6.831	AHY	GC	780	260	45.68	52.34	46.32	96.72
11/21/2002	5.352	AHY	GC	750	246	47.46	53.30	46.78	101.90
11/21/2002	7.063	AHY	GC	705	246	44.86	49.89	46.12	95.52
11/21/2002	6.891	AHY	GC	660	251	46.61	52.14	48.85	99.20
11/21/2002	6.973	HY	GC	770	245	42.00	49.89	48.12	95.84
11/21/2002	5.342	AHY	GC	850	255	46.67	52.35	46.04	99.46
11/21/2002	5.328	AHY	GC	800	256	47.37	52.40	48.01	100.56
11/21/2002	6.963	AHY	GC	825	253	46.57	51.09	46.17	99.26
11/21/2002	6.761	AHY	GC	850	254	46.51	54.16	49.71	101.69
11/21/2002	7.037	AHY	GC	785	251	46.57	53.15	47.55	100.89

AGE[1]: AHY = after hatch-year; HY = hatch year

AREA[2]: GC = gulf coast; RP = rice prairie; MASS[3]: body mass at capture minus estimated weight of rice in upper digestive tract

APPENDIX A. Continued.

DATE	FREQ	AGE[1]	AREA[2]	MASS[3] (g)	WING CHORD (mm)	CULMEN (mm)	TARSUS (mm)	MIDDLE TOE (mm)	HEAD LENGTH (mm)
11/21/2002	6.882	AHY	GC	730	241	43.56	48.83	44.22	96.36
11/21/2002	5.371	AHY	GC	680	238	42.09	48.47	45.58	93.90
11/21/2002	7.112	AHY	GC	785	255	47.05	52.45	47.21	101.25
11/21/2002	6.737	AHY	GC	660	251	45.72	48.29	44.90	96.91
11/21/2002	6.863	HY	GC	750	251	47.95	51.37	44.93	100.38
11/21/2002	7.153	AHY	GC	890	253	45.96	50.11	45.63	99.60
11/21/2002	6.663	AHY	GC	830	258	47.78	50.72	47.15	101.64
11/21/2002	7.013	HY	GC	825	263	46.76	52.41	48.94	101.66
11/21/2002	6.813	AHY	GC	915	259	47.43	52.93	48.01	102.44
11/21/2002	7.131	AHY	GC	860	252	48.25	52.21	48.09	102.14
11/21/2002	7.562	HY	GC	870	250	42.34	46.63	45.06	93.03
11/10/2003	5.771	HY	GC	820	241	44.63	50.80	49.80	97.29
11/10/2003	6.474	AHY	GC	810	247	46.86	49.18	45.26	99.66
11/18/2003	7.690	HY	GC	625	233	44.52	48.87	47.53	99.85
11/18/2003	6.209	HY	GC	805	256	45.39	50.12	46.30	99.90
11/18/2003	6.425	AHY	GC	770	245	45.01	49.78	46.98	98.37
11/18/2003	6.180	AHY	GC	805	247	46.62	52.26	48.53	103.29
11/18/2003	6.359	HY	GC	745	243	45.15	50.43	45.20	98.19
11/18/2003	6.272	HY	GC	820	248	46.64	51.83	48.79	101.31
11/18/2003	7.540	HY	GC	760	232	46.48	48.72	42.65	97.48
11/18/2003	7.721	HY	GC	700	232	44.39	48.63	43.43	95.78
11/18/2003	6.078	AHY	GC	860	246	45.47	50.55	45.43	100.24
11/18/2003	6.095	AHY	GC	760	244	44.93	48.21	45.22	96.72
11/18/2003	6.149	AHY	GC	845	251	48.22	50.73	48.57	101.79
11/18/2003	7.070	AHY	GC	925	250	48.13	50.17	45.15	101.25
11/18/2003	7.680	AHY	GC	780	249	47.46	51.56	46.39	100.10
11/18/2003	6.840	AHY	GC	900	264	49.77	52.21	47.86	104.47
11/18/2003	5.921	HY	GC	830	241	46.23	52.35	44.36	99.08
11/18/2003	6.570	HY	GC	640	238	43.68	48.74	46.52	94.23
11/18/2003	6.730	AHY	GC	810	251	48.70	51.25	45.78	100.55
11/18/2003	5.751	AHY	GC	850	250	48.18	52.44	45.85	102.97
11/18/2003	6.810	AHY	GC	795	236	46.48	51.13	46.88	98.21
11/18/2003	6.620	HY	GC	840	242	47.53	52.77	45.12	101.43
11/18/2003	5.930	HY	GC	740	245	48.55	51.71	48.44	100.07
11/18/2003	5.960	AHY	GC	770	241	46.59	50.03	45.57	99.93
11/18/2003	6.680	HY	GC	690	241	45.23	50.51	47.08	100.03
11/18/2003	6.701	HY	GC	855	247	48.76	49.64	45.05	103.42

AGE[1]: AHY = after hatch-year; HY = hatch year

AREA[2]: GC = gulf coast; RP = rice prairie; MASS[3]: body mass at capture minus estimated weight of rice in upper digestive tract

APPENDIX A. Continued.

DATE	FREQ	AGE[1]	AREA[2]	MASS[3] (g)	WING CHORD (mm)	CULMEN (mm)	TARSUS (mm)	MIDDLE TOE (mm)	HEAD LENGTH (mm)
11/18/2003	5.850	HY	GC	720	230	50.44	50.55	45.74	99.70
11/18/2003	6.691	HY	GC	730	243	43.13	50.71	48.73	95.05
11/18/2003	5.830	AHY	GC	690	245	47.36	50.46	45.14	100.12
11/18/2003	6.900	HY	GC	860	255	49.74	49.86	44.95	103.08
11/18/2003	6.790	HY	GC	800	247	46.24	52.74	45.50	100.35
11/18/2003	6.769	HY	GC	800	255	46.77	49.88	46.91	101.23
11/18/2003	6.609	HY	GC	750	238	44.77	50.72	45.04	98.78
11/18/2003	5.900	HY	GC	810	239	42.64	47.42	45.09	94.21
11/18/2003	7.009	HY	GC	750	240	45.59	48.86	43.11	97.93
11/23/2003	5.835	AHY	GC	750	233	46.77	47.54	42.99	97.02
11/23/2003	6.750	HY	GC	880	237	48.98	50.49	47.10	102.19
11/23/2003	6.950	AHY	GC	850	241	45.33	50.66	47.48	97.22
11/23/2003	7.090	HY	GC	750	249	47.24	51.81	46.66	99.92
11/23/2003	6.541	HY	GC	910	243	47.70	51.26	47.38	101.06
11/23/2003	7.080	HY	GC	790	244	45.65	50.40	45.11	95.53
11/23/2003	6.961	HY	GC	955	250	47.60	50.75	48.53	100.65
11/23/2003	6.021	HY	GC	765	248	44.67	50.04	42.90	96.58
11/23/2003	5.890	HY	GC	865	251	45.84	50.22	45.85	97.05
11/23/2003	6.640	HY	GC	895	236	47.57	50.57	46.68	98.88
11/23/2003	5.970	AHY	GC	810	243	48.36	51.39	45.18	101.28
11/23/2003	5.951	AHY	GC	800	256	49.32	47.50	43.68	103.23
11/23/2003	7.099	AHY	GC	805	256	44.04	50.39	42.92	96.11
11/23/2003	6.010	HY	GC	790	247	48.91	51.95	46.32	103.53
11/23/2003	7.660	HY	GC	890	255	46.39	47.31	47.03	99.46
11/23/2003	6.235	HY	GC	870	253	47.95	51.07	47.61	99.80
11/23/2003	6.820	AHY	GC	940	255	49.56	53.01	47.06	104.69
11/23/2003	5.991	AHY	GC	825	241	45.50	51.39	46.38	99.83
11/23/2003	5.881	HY	GC	755	247	47.18	48.33	43.73	97.36
11/23/2003	6.222	HY	GC	670	226	44.02	47.67	44.10	94.34
11/23/2003	7.020	AHY	GC	715	255	48.09	47.94	46.00	100.20
11/23/2003	7.610	HY	GC	755	244	47.21	49.30	45.06	100.22
11/23/2003	5.981	HY	GC	650	260	46.63	51.80	46.10	100.05
11/23/2003	6.374	HY	GC	690	242	46.51	52.00	47.57	100.52
11/23/2003	7.060	HY	GC	845	257	47.92	49.23	47.36	99.39
11/23/2003	6.485	HY	GC	755	252	49.25	51.50	47.01	103.78
11/23/2003	6.971	AHY	GC	825	246	48.82	47.04	42.92	99.28
11/23/2003	5.785	AHY	GC	850	250	43.56	47.62	45.66	95.45

AGE[1]: AHY = after hatch-year; HY = hatch year

AREA[2]: GC = gulf coast; RP = rice prairie; MASS[3]: body mass at capture minus estimated weight of rice in upper digestive tract

APPENDIX A. Continued.

DATE	FREQ	AGE[1]	AREA[2]	MASS[3] (g)	WING CHORD (mm)	CULMEN (mm)	TARSUS (mm)	MIDDLE TOE (mm)	HEAD LENGTH (mm)
11/23/2003	6.160	AHY	GC	910	255	47.64	50.40	48.08	101.40
11/23/2003	7.560	HY	GC	730	246	43.82	48.75	47.65	96.03
11/23/2003	6.447	HY	GC	740	252	44.13	48.76	46.84	96.98
11/23/2003	6.247	HY	GC	770	245	45.53	47.74	47.48	99.96
11/23/2003	6.055	HY	GC	700	233	45.29	46.01	45.14	96.73
11/23/2003	7.520	AHY	GC	930	260	47.69	50.12	46.11	103.07
11/23/2003	7.629	HY	GC	800	245	48.04	49.25	47.09	100.63
11/23/2003	6.343	HY	GC	750	237	44.37	48.37	45.42	96.86
11/23/2003	6.334	HY	GC	725	256	49.32	49.29	46.64	102.53
11/23/2003	6.497	HY	GC	770	240	43.44	49.34	47.76	95.42
11/23/2003	6.171	HY	GC	715	230	45.69	47.00	42.04	98.53
11/23/2003	6.195	HY	GC	645	235	46.47	47.86	44.34	99.09
11/23/2003	6.072	AHY	GC	835	255	49.15	48.16	47.18	102.68
11/23/2003	6.419	HY	GC	775	234	45.58	50.66	47.27	97.73
11/23/2003	6.110	AHY	GC	825	255	47.88	50.43	48.20	100.78
11/23/2003	6.141	AHY	GC	875	253	45.95	49.60	46.11	98.91
11/23/2003	7.579	AHY	GC	880	258	45.61	48.39	47.72	98.97
11/23/2003	6.350	AHY	GC	740	251	46.99	47.27	45.23	97.75
11/23/2003	6.296	HY	GC	705	243	46.68	50.96	45.06	99.64
11/23/2003	6.398	HY	GC	850	243	47.71	45.81	44.60	99.60
11/23/2003	6.047	AHY	GC	785	252	45.09	46.93	45.97	95.17
11/23/2003	7.710	HY	GC	860	230	46.12	51.45	47.82	101.28
11/23/2003	6.309	AHY	GC	800	255	46.40	49.31	45.17	100.50
11/23/2003	7.750	AHY	GC	740	242	47.44	51.54	47.12	99.97
11/23/2003	7.651	AHY	GC	750	249	45.39	51.09	49.12	99.77
11/23/2003	6.102	AHY	GC	845	252	48.31	50.67	47.79	101.57
11/28/2003	5.504	HY	RP	790	247	49.19	49.23	43.42	102.40
11/28/2003	6.061	HY	RP	835	238	44.62	49.79	45.85	99.51
11/28/2003	6.890	AHY	RP	800	249	46.97	50.61	47.47	98.05
11/28/2003	6.387	HY	RP	890	255	43.02	49.74	43.26	94.08
11/28/2003	6.031	AHY	RP	740	238	47.58	47.78	40.11	98.06
11/28/2003	5.328	AHY	RP	820	244	45.40	47.12	44.52	98.92
11/28/2003	5.517	HY	RP	770	245	42.57	49.62	41.52	96.85
11/28/2003	5.690	HY	RP	815	246	46.67	49.97	48.28	98.12
11/28/2003	5.550	HY	RP	810	252	45.42	52.56	48.69	98.73
11/28/2003	5.680	HY	RP	800	245	44.80	50.77	45.65	96.82
11/28/2003	6.993	AHY	RP	890	253	47.13	51.35	46.75	100.39

AGE[1]: AHY = after hatch-year; HY = hatch year

AREA[2]: GC = gulf coast; RP = rice prairie; MASS[3]: body mass at capture minus estimated weight of rice in upper digestive tract

APPENDIX A. Continued.

DATE	FREQ	AGE[1]	AREA[2]	MASS[3] (g)	WING CHORD (mm)	CULMEN (mm)	TARSUS (mm)	MIDDLE TOE (mm)	HEAD LENGTH (mm)
11/28/2003	5.630	HY	RP	830	248	44.74	52.55	50.27	96.92
11/28/2003	5.734	HY	RP	820	238	47.38	51.65	47.78	99.49
11/28/2003	7.550	HY	RP	720	237	45.63	51.57	48.38	99.58
11/28/2003	6.860	HY	RP	765	253	46.75	49.51	48.24	99.27
11/28/2003	6.934	HY	RP	745	246	47.70	51.59	51.27	101.78
11/28/2003	6.907	HY	RP	800	242	47.02	50.12	47.34	98.32
11/28/2003	7.846	HY	RP	740	242	47.81	49.26	45.44	100.43
11/28/2003	7.037	AHY	RP	1000	251	48.02	49.83	48.28	102.39
11/28/2003	6.630	AHY	RP	935	259	47.97	51.97	48.89	101.11
11/28/2003	6.659	HY	RP	765	232	45.83	51.33	46.56	100.38
11/28/2003	6.560	HY	RP	695	235	45.74	48.38	43.99	98.06
11/28/2003	6.600	HY	RP	810	243	47.23	50.20	46.82	100.77
11/28/2003	6.710	HY	RP	640	228	43.10	48.54	42.68	96.80
11/30/2003	7.030	AHY	RP	900	269	51.08	52.82	47.79	104.08
11/30/2003	6.919	AHY	RP	895	249	46.82	51.98	51.08	101.02
11/30/2003	7.441	HY	RP	780	234	42.48	50.89	44.95	97.20
11/30/2003	6.851	AHY	RP	765	240	46.77	51.72	51.48	101.90
11/30/2003	5.840	AHY	RP	800	250	47.84	49.83	48.86	102.67
11/30/2003	7.670	HY	RP	735	239	45.28	48.32	46.64	95.28
11/30/2003	7.280	HY	RP	765	247	48.25	49.91	46.15	98.24
11/30/2003	6.579	AHY	RP	820	252	49.07	53.06	48.19	103.12
11/30/2003	7.530	HY	RP	775	241	45.44	51.43	46.25	101.05
11/30/2003	5.820	AHY	RP	790	244	50.18	51.14	46.54	102.06
11/30/2003	6.780	HY	RP	715	243	43.86	50.76	47.00	96.51
11/30/2003	6.800	AHY	RP	810	245	45.07	49.61	45.29	99.54
11/30/2003	6.881	AHY	RP	740	250	43.07	49.91	46.26	93.90
11/30/2003	7.330	HY	RP	855	249	46.43	51.73	47.21	99.80
11/30/2003	7.471	HY	RP	720	247	45.22	50.26	46.57	99.02
11/30/2003	7.200	HY	RP	770	244	46.63	50.14	46.83	101.97
11/30/2003	5.910	HY	RP	760	247	43.96	49.98	47.30	96.30
11/30/2003	7.902	HY	RP	680	241	41.15	47.90	44.87	93.36
11/30/2003	5.800	AHY	RP	820	255	47.74	50.74	46.83	101.45
11/30/2003	7.242	HY	RP	880	248	48.31	50.66	45.90	99.92
11/30/2003	7.153	HY	RP	735	253	47.52	52.34	47.31	101.41
11/30/2003	6.911	AHY	RP	785	243	46.27	51.66	46.84	101.43
11/30/2003	6.551	AHY	RP	905	258	46.43	52.41	48.76	102.09
11/30/2003	7.800	HY	RP	615	244	46.66	50.58	44.18	98.52

AGE[1]: AHY = after hatch-year; HY = hatch year

AREA[2]: GC = gulf coast; RP = rice prairie; MASS[3]: body mass at capture minus estimated weight of rice in upper digestive tract

APPENDIX A. Continued.

DATE	FREQ	AGE[1]	AREA[2]	MASS[3] (g)	WING CHORD (mm)	CULMEN (mm)	TARSUS (mm)	MIDDLE TOE (mm)	HEAD LENGTH (mm)
11/30/2003	7.832	HY	RP	690	242	44.24	51.12	46.76	97.85
11/30/2003	7.260	HY	RP	770	243	47.39	50.87	48.52	101.09
11/30/2003	6.759	AHY	RP	930	257	46.32	53.44	48.32	99.32
11/30/2003	5.860	AHY	RP	810	248	45.67	49.60	46.56	101.24
11/30/2003	7.742	HY	RP	790	255	46.52	50.40	47.64	101.14
11/30/2003	7.622	HY	RP	760	249	45.68	49.10	45.69	100.52
11/30/2003	7.732	HY	RP	730	233	45.23	49.75	45.28	97.84
11/30/2003	7.780	AHY	RP	770	238	45.65	48.52	44.25	95.23
11/30/2003	7.602	AHY	RP	815	249	45.63	52.38	46.43	99.44
11/30/2003	7.982	HY	RP	760	248	44.23	51.45	45.34	98.10
11/30/2003	7.930	AHY	RP	720	248	45.50	51.87	48.07	99.44
11/30/2003	7.421	AHY	RP	855	254	47.68	51.52	46.30	104.23
11/30/2003	7.301	AHY	RP	805	256	49.31	50.63	46.28	105.56
11/30/2003	7.642	HY	RP	715	254	47.71	50.97	47.44	97.90
11/30/2003	7.053	HY	RP	675	245	43.42	49.71	46.03	95.93
11/30/2003	7.370	HY	RP	790	247	46.40	49.37	44.63	97.77
11/30/2003	7.922	AHY	RP	855	249	45.61	52.28	48.36	100.04
11/30/2003	6.831	HY	RP	766	246	46.71	50.89	46.66	100.94

AGE[1]: AHY = after hatch-year; HY = hatch year

AREA[2]: GC = gulf coast; RP = rice prairie

MASS[3]: body mass at capture minus estimated weight of rice in upper digestive tract

APPENDIX B.

APPENDIX B. Program MARK models used to explain variation in winter survival of female northern pintails wintering along the mid-coast of Texas in 2002–03 and 2003–04.

Model	K	AIC_c	AIC_c Weight	ΔAIC_c
Age[1] + year[2] + TT[5]	7	1067.56	0.22	0.0
Age + year + TT	5	1067.76	0.20	0.2
TT	3	1068.53	0.14	1.0
Age + year + T[4]	4	1068.79	0.12	1.2
Age + year * TT + mass[3]	8	1068.96	0.11	1.4
Age + T	3	1070.03	0.06	2.5
T	2	1070.20	0.06	2.6

Age[1] = age of bird

Year[2] = year of study

Mass[3] = corrected body mass

T[4] = linear trend

TT[5] = quadratic trend

VITA

James T. Anderson

EDUCATION:

B.S., Poultry Science, University of Arkansas, May 1996.

B.S., Animal Science, University of Arkansas, December 2000.

EMPLOYMENT:

2007–2008: Conservation Specialist
National Headquarters, Memphis, Tennessee
Ducks Unlimited, Inc.

2002–2007: Graduate Research Fellow, Caesar Kleberg Wildlife Research Institute, Texas A&M University – Kingsville, Kingsville, Texas
Thesis Title: *Survival, Habitat Use, and Movements of Female Northern Pintails Wintering Along the Texas Coast*

2001–2007: Research Associate
Caesar Kleberg Wildlife Research Institute
Texas A&M University – Kingsville, Kingsville, Texas

2000–2001: Project Technician
Arkansas Field Office, North Little Rock, Arkansas
Ducks Unlimited, Inc.

2000: Research Assistant
Erickson and Minnedosa, Manitoba, and Egeland, North Dakota
Delta Waterfowl Foundation

Permanent Address: 6907 Amberly Grove Cove, Cordova, TN 38018