

1996

## **Movements, Habitat Use, and Survival of Female Northern Pintails in Southwestern Louisiana.**

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**MOVEMENTS, HABITAT USE, AND  
SURVIVAL OF FEMALE  
NORTHERN PINTAILS IN SOUTHWESTERN LOUISIANA**

**A Dissertation**

**Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
in partial fulfillment of the  
requirements for the degree of  
Doctor of Philosophy**

**in**

**The School of Forestry, Wildlife, and Fisheries**

**by  
Robert Ripley Cox, Jr.  
B.S., University of Georgia, 1987  
M.S., Utah State University, 1993  
December 1996**

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To the few people left in this world who really know ducks - people  
who have a deep understanding and appreciation  
of them, people who know what's  
happening in the field as well as  
in the literature, people who plan their lives around them,  
and most importantly, people who hunt them as a religion;  
just reading about 'em ain't enough.

## **Acknowledgments**

I thank my advisor, Dr. Alan Afton, and other committee members, including Drs. Robert Chabreck, Vernon Wright, Robert Reigh, Ronald Delaune, and particularly Richard Pace, for advice and encouragement throughout my project. My coursework at LSU taught me how to deal with “pretty data”, but Richard Pace taught me how to deal with data collected in the real world. My office partner, Larry Reynolds, also taught me a lot about statistics, and our friendship kept me sane throughout most of my stay at LSU. Larry also is the best duck hunting partner that anyone could ever hope to find, and he made my duck seasons in Louisiana especially memorable. I am grateful for additional statistical advice and encouragement from D. H. Johnson, W. E. Newton, and T. L. Shaffer at Northern Prairie Science Center. Financial support for my research was provided by Regions 2 and 4 and Office of Migratory Bird Management of the U.S. Fish and Wildlife Service (USFWS), Ducks Unlimited through the Institute for Wetlands and Waterfowl Research, Louisiana State University Alumni Association, National Wetlands Research Center of the National Biological Service, Louisiana Cooperative Fish and Wildlife Research Unit, Lacassane Land Co. (LLC), Louisiana Department of Wildlife and Fisheries (LDWF), Munchrath Properties, Inc. (MPI), Amoco Production Co., and Gulf Coast Joint Venture of the NAWMP. Field assistance was provided by A. J. Chmielewski, B. C. Crouch, D. W. Dippel, T. F. Fondell, C. Hoffpauir, M. J. Humpert, J. J. Lane, D. Miller, R. E. Olsen, K. L. Richardson, B. K. Scheick, M. K. Sperry, K. J. Taylor, B. T. Vogl, M. P. Vrtiska, and D. A. Williams. These guys were “rode hard and put up wet” most of the time, and I am especially grateful for their efforts. J. Gould, J.



Miller, F. H. Roetker, and C. B. Stamey piloted aircraft during aerial telemetry, and R. N. Helm, D. Richard, F. H. Roetker, and P. M. Yakupzack generously shared their knowledge of waterfowl use of the area. Cameron Prairie National Wildlife Refuge (NWR), Lacassine NWR, LLC, LDWF, Rockefeller Wildlife Refuge, and Sabine NWR kindly loaned rocket-netting equipment and other supplies. LDWF provided 2-way radios and allowed us to use their frequency for communications. J. E. Austin of Northern Prairie Science Center, Jamestown, North Dakota, provided several transmitters. B. G. Addison, R. R. Bielefeld, M. Broussard, P. C. Chadwick, P. R. Garretson, R. W. Grafe, J. L. Moore, D. A. Munchrath, C. D. Parker, M. S. Peters, V. Rettig, L. A. Reynolds, C. L. Ryan, M. J. Stewart, and T. J. Yerkes helped trap and/or instrument birds. I thank LLC, Lacassine NWR, MPI, and Sweet Lake Land and Oil Co. for preparing trapping sites. I am grateful to the U.S. Forest Service and USFWS Law Enforcement office in Slidell, Louisiana, and Lacassine NWR for providing trailers for housing and to S. R. Aycock, USFWS, Jackson, Mississippi, for assistance in moving trailers and supporting my research. I thank the Agricultural Stabilization and Conservation Service and Soil Conservation Service offices in southwestern Louisiana for providing agricultural data. I thank R. H. Hier, Minnesota Dep. Nat. Resour., for providing the print that served as a reward for hunters. R. M. Windingstad, National Wildlife Health Research Center, Madison, WI, necropsied several carcasses. I thank P. C. Chadwick, M. Finley, C. W. Jeske, J. L. Moore, and W. Norling for collecting survival data on radio-tagged females that emigrated north of southwestern Louisiana. Numerous people outside my committee reviewed one or more chapters, including J. E.

Austin, B. D. J. Batt, D. A. Brandt, C. F. Bryan, J. Connelly, R. T. Eberhardt, J. P. Fleskes, R. J. Greenwood, J. Haskins, R. N. Helm, D. W. Howerter, D. H. Johnson, W. D. Koenig, G. L. Krapu, C. R. LeSchack, M. R. Miller, J. L. Moore, W. E. Newton, P. J. Pietz, D. P. Rave, T. L. Shaffer, P. M. Yakupzack, and K. Yasukawa. Finally, I thank my wife, Kim Medley Cox, for putting up with me, my student status since our marriage 14 years ago, and my love and pursuit of ducks all these years; we finally made it, honey!

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## Abstract

I developed portable platforms for setting rocket nets in open-water habitats, and used them to capture 1116 waterfowl of 7 species during winters 1991-92 and 1992-93 in southwestern Louisiana. Distance and duration of evening flights of female northern pintails (Anas acuta; hereafter pintails) from Lacassine National Wildlife Refuge increased with date within wintering period, and generally were greater than previously reported estimates for wintering waterfowl. I found that diurnal use of refuges by females increased during hunting seasons, contradicting Tamisier's hypothesis that use of refuges by pintails in southwestern Louisiana is not influenced by hunting. Female pintails extensively used privately owned rice and fallow (idle) agriculture, particularly at night. Use of mini-refuges was low relative to that of large permanent pools. This finding does not support Rave and Cordes' prediction that mini-refuges would prove to be more important than pools to wintering pintails. I attribute low use of mini-refuges during my study primarily to lack of water and cover management, but location, small size, and irregular shape of some of these areas may preclude extensive use by pintails. Early mortality (death within the first 4 days after radio-tagging) of females was related to flight quality (scored as good, moderate, or poor upon release). Early mortality and flight quality, in turn, were related to the interaction of holding time (time from capture until release) and number of waterfowl captured in rocket nets. Survival of females in southwestern Louisiana was lower during hunting than during non-hunting seasons, and immatures survived at lower rates than adults. Despite conservative hunting regulations (30-day season and 1 pintail daily), hunting mortality rates ( $0.165 \pm 0.034[\text{SE}]$  for adults

and  $0.315 \pm 0.053$  for immatures) of female pintails in southwestern Louisiana were higher than estimates for other female dabbling ducks (within age classes) during winter. If lower daily energy expenditure and hunting mortality of female pintails are management goals, I recommend that availability of moist-soil and agricultural foods on key refuges be increased as a first step.

## **Chapter 1**

### **Introduction**

Numbers of breeding northern pintails (Anas acuta; hereafter pintails) approached or exceeded 6 million during the 1950s (after breeding pair surveys began in 1955) and throughout the 1970s (U.S. Fish and Wildlife Service [USFWS] and Canadian Wildlife Service [CWS] 1995). However, numbers of breeding pintails have not exceeded 3 million since 1983. This population decline has occurred despite high reproductive potential of pintails relative to other species of ducks; they breed in their first year, lay moderate to large clutches, and are fairly persistent renesters (Bellrose 1976). While drought and agricultural impacts on breeding areas contributed to their decline (Ducks Unlimited, Inc. 1990), cross-seasonal effects from factors during other portions of the annual cycle also may influence recruitment in pintails and other dabbling ducks (Heitmeyer and Fredrickson 1981, Anderson and Batt 1983, Kaminski and Gluesing 1987, Raveling and Heitmeyer 1989). Because pintails and other ducks spend the majority of the non-breeding portion of the annual cycle on wintering areas, a clear understanding of wintering ecology of pintails may be crucial to managing populations.

Southwestern Louisiana is the most important pintail wintering area in the Mississippi Flyway. From 1981-1995, 81% of the pintails surveyed in the Mississippi Flyway were found in Louisiana, and numbers of pintails wintering in Louisiana explained 68% of the variation in pintail numbers in the flyway (USFWS, unpubl. mid-winter surveys). Further, 72% of the pintails surveyed within the state during this period were found in southwestern Louisiana, and numbers of pintails wintering in southwestern

Louisiana explained 91% of the variation in pintail numbers in the state (Louisiana Dep. of Wildl. and Fisheries, unpubl. mid-winter surveys).

Despite the importance of southwestern Louisiana to wintering pintails, little is known about their wintering ecology in this region. Diurnal observations of pintails on Lacassine Pool, a primary concentration area in the region, indicated that pintails feed little on this refuge, departing after sunset in northerly directions (Tamisier 1976). This finding suggests that pintails meet dietary needs primarily by foraging nocturnally in agricultural fields. Thus, my primary objectives were to: (1) estimate distance, duration, and departure time of evening flights of pintails from Lacassine National Wildlife Refuge, identify important sources of variation influencing flight parameters, and interpret findings with respect to refuging theory and energy expenditure, (2) estimate diel (particularly nocturnal) use of habitats (based on sanctuary and cover-type attributes) by pintails in southwestern Louisiana, and identify important factors influencing use of habitats, and (3) estimate survival rates of pintails in this region, estimate mortality rates due to hunting and non-hunting sources, and identify important factors related to survivorship.

## **LITERATURE CITED**

- Anderson, M. G., and B. D. J. Batt. 1983. Workshop on the ecology of wintering waterfowl. Wildl. Soc. Bull. 11:22-24.
- Bellrose, F. C. 1976. Ducks, geese, and swans of North America. Stackpole Books, Harrisburg, Pa. 544pp.
- Ducks Unlimited, Inc. 1990. Sprig: population recovery strategy for the northern pintail. Ducks Unlimited, Inc., Long Grove, Ill. 30pp.



- Heitmeyer, M. E., and L. H. Fredrickson. 1981. Do wetland conditions in the Mississippi Delta hardwoods influence mallard recruitment? *Trans. N. Am. Wildl. Nat. Resour. Conf.* 46:44-57.
- Kaminski, R. M., and E. A. Gluesing. 1987. Density- and habitat-related recruitment in mallards. *J. Wildl. Manage.* 51:141-148.
- Raveling, D. G., and M. E. Heitmeyer. 1989. Relationships of population size and recruitment of pintails to habitat conditions and harvest. *J. Wildl. Manage.* 53:1088-1103.
- Tamisier, A. 1976. Diurnal activities of green-winged teal and pintail wintering in Louisiana. *Wildfowl* 27:19-32.
- U. S. Fish and Wildlife Service and Canadian Wildlife Service. 1995. Waterfowl population status, 1995. *Off. Migr. Bird Manage.*, Laurel, Md. 45pp.

## Chapter 2

### Portable Platforms for Setting Rocket Nets in Open-water Habitats\*

#### INTRODUCTION

Projectile-type net traps (Dill and Thornsberry 1950) have been used extensively to capture a variety of birds including wild turkeys (Meleagris gallopavo), brown-headed cowbirds (Molothrus ater), sage grouse (Centrocercus urophasianus), bald eagles (Haliaeetus leucocephalus), sandhill cranes (Grus canadensis) and waterfowl (reviewed by Day et al. 1980, Schemnitz 1994). Most rocket-netting of aquatic birds is done from permanent sites that: (a) are free of vegetation and debris to allow visibility and unobstructed projection of nets, (b) allow easy and expedient access for baiting and removal of trapped birds, and (c) are located on land, but usually near water, to allow bait, nets, projectiles, electrical wiring and trapped birds to remain dry. Construction and maintenance of permanent sites is time-consuming and costly. Budget limitations, landowner restrictions, site-specific limitations (e.g., fluctuating water levels) or reluctance of target species to approach shore may make construction of permanent trapping sites infeasible. I describe here a method of setting rocket nets on portable platforms in open-water habitats.

#### STUDY AREA AND METHODS

I used portable rocket-net platforms to capture waterfowl from 28 Sep.-27 Oct. 1991 and 28 Sep.-25 Oct. 1992. Three flooded trapping sites were used: (1) a 19-ha fallow field located 8 km south of Gueydan, LA (29°57'N, 92°31'W), (2) a

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25-ha domestic rice (*Oryza sativa*) field located 10 km southwest of Lake Arthur, LA (30°02'N, 92°48'W), and (3) two moist-soil units (18 ha each) located on Lacassine National Wildlife Refuge (NWR; 30°01'N, 92°54'W).

I used 17.4 X 13.4-m turkey nets equipped with 0.6-m tapered fringes, with mesh sizes of 3-5 cm. Projectiles consisted of rockets and W-115 charges (color-coded yellow; Winn-Star, Inc., Marion, IL). I followed U.S. Fish and Wildlife Service (USFWS) safety procedures for transport and use of rocket-net charges. Nets were equipped with four rockets each, and were anchored with five, 0.5-m lines. Each anchor line was tied to two, 5-cm wide rubber bands made from automotive tire inner tube to reduce backlash. I used 46-cm long stakes made from 1.27-cm diameter rolled steel to anchor rubber bands.

I constructed platforms from 1 cm X 1.2 m X 2.4 m sheets of untreated industrial-grade plywood (Fig. 2.1). Each plywood sheet was cut twice lengthwise into three 0.4 X 2.4-m platforms. I camouflaged upper and edge surfaces of platforms by smearing them with a light coat of mud. Platforms were supported either by standard 20.3 X 20.3 X 40.6-cm cinder blocks or by 5.1 X 10.2 cm wall studs cut to 38-cm lengths. In deep water (8-36 cm), a cinder block was placed in the middle of each supporting platform, with each platform sharing a block with the next platform in line. In shallow water (2-7 cm), wall studs were placed at four equidistant points beneath each platform. I generally used nine platforms to support each net; however, the exact number was dependent upon the way nets were gathered for firing. Approximate costs

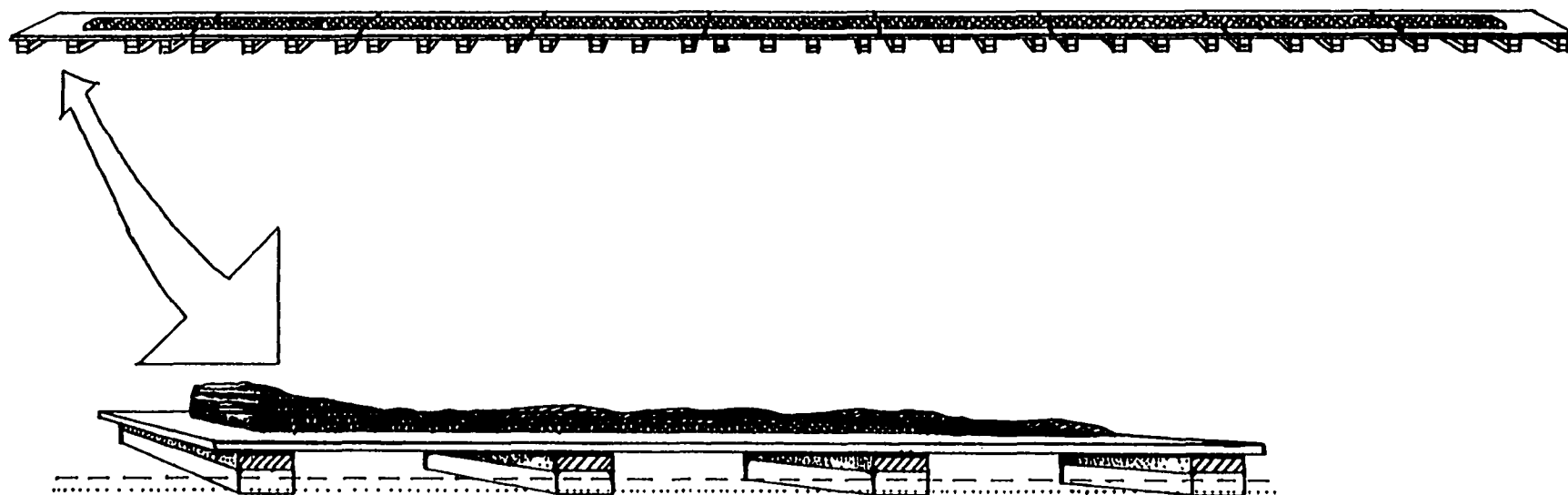


Fig. 2.1. Platforms (top) for a single 17.4 X 13.4 m rocket net set in water 2 cm deep. Four sets of two 5.1 X 10.2 cm wall studs are used to support each of nine, 1 cm X 0.4 m X 2.4 m platforms. Wall studs can be nailed to platforms to expedite assembly. Inset (bottom) shows magnified view of left-most platform. Dashed line represents water surface and dotted line represents sediment surface.

of platforms, including supports for a single net, were \$44.00 and \$51.00 (US) for deep and shallow water sets, respectively.

I wired charges in series using 16-20 gauge solid copper thermostat (waterproof) wire and detonated them with 650-A 12-V automotive batteries via remote-control units (Sharp and Lokemoen 1980). To make rockets as inconspicuous as possible, I usually placed rockets on mounds constructed of mud and vegetation located 0.5-0.8 m in front of nets, and securely staked electrical wiring below the water surface. On two occasions, I placed rockets behind nets in launchers. I angled end rockets approx. 30° laterally to facilitate net extension.

I placed two nets close together (3 m) and detonated them simultaneously (on a single circuit) on eight occasions; I set single nets on two occasions. I camouflaged platforms, nets and rockets with vegetation. I heavily baited an area extending from 1 m directly in front of nets to attract birds to the site, and progressively decreased the size of the baited area over time (2-8 d) to concentrate birds close to the net. I used unmilled domestic rice as the primary bait, but also used smaller amounts of buckwheat (Fagopyrum esculentum), white millet (Pennisetum glaucum), dove proso (Panicum miliaceum) and brown-top millet (Panicum ramosum).

## RESULTS AND DISCUSSION

I fired a total of 18 nets from 10 detonations using the technique, and captured 952 northern pintails (Anas acuta, hereafter pintails), my target species. I incidentally captured 64 blue-winged teal (Anas discors), 50 fulvous whistling-ducks (Dendrocygna bicolor), 25 white-fronted geese (Anser albifrons), 11 green-winged teal (Anas crecca),

12 mottled ducks (*Anas fulvigula*) and two northern shovelers (*Anas clypeata*).

Numbers of waterfowl captured per successful detonation ( $n = 9$ ) ranged from 15 to 524 ( $\bar{x} = 124$ ,  $SE = 53$ ). One successful detonation of a double-net set resulted in poor net throws, and only 83 of an estimated 400 ducks within range of nets were captured. I believe that rockets, which were located in front of nets on this occasion, were placed too close to platforms causing dislodged platforms to become entangled in the extending net. In the single unsuccessful detonation, one double-net set fired only one end rocket from one of the nets, and no birds were captured. Failure of additional rockets to detonate was caused by a submerged, bare (non-insulated) electrical connection, which produced a short circuit.

I observed low incidence of mortality using this technique. Twelve of 1116 captured waterfowl (all pintails) died during capture. Eleven individuals were drowned; one individual was found dead in the net, but exhibited no external signs of injury. The drowning mortalities occurred when two simultaneous firings of three nets (one double-set and one single-set) captured 594 ducks, mostly pintails. The drowned ducks became trapped between platforms and the portion of the net that was staked. I believe that such mortalities could be avoided by staking nets in front of, rather than behind, platforms.

I found that escaping birds were a minor problem (29 of 1116 captured ducks), even when water depths were sufficient for birds to swim from under nets. I minimized potential escapes by approaching fired nets quickly and removing birds from the net perimeter first. I observed wet plumage on birds that spent longer than 15 min in nets and recommend holding birds until plumage dries before releasing. I also recommend

that sufficient personnel be available (i.e., approx. one person per 20 birds captured) to remove birds from nets quickly so that capture myopathy is minimized (Bollinger et al. 1989, Dabbert and Powell 1993).

In conclusion, I believe that the major advantage of the technique is increased portability, allowing nets to be placed far from shore where some species, such as pintails, frequent. I found that the technique was effective in capturing waterfowl, and believe that it is applicable to other avian species using open-water habitats.

### LITERATURE CITED

- Bollinger, T., G. Wobeser, R. G. Clark, D. J. Nieman, and J. R. Smith. 1989. Concentration of creatine kinase and aspartate aminotransferase in the blood of wild Mallards following capture by three methods for banding. *J. Wildl. Dis.* 25:225-231.
- Dabbert, C. B., and K. C. Powell. 1993. Serum enzymes as indicators of capture myopathy in mallards (*Anas platyrhynchos*). *J. Wildl. Dis.* 29:304-309.
- Day, G. I., S. D. Schemnitz, and R. D. Taber. 1980. Capturing and marking wild animals. Pages 61-88 in S. D. Schemnitz, ed. *Wildlife management techniques manual*, Fourth ed. The Wildl. Soc., Washington, DC.
- Dill, H. H., and W. H. Thornsberry. 1950. A cannon-projected net trap for capturing waterfowl. *J. Wildl. Manage.* 14:132-137.
- Schemnitz, S. D. 1994. Capturing and handling wild animals. Pages 106-124 in T. A. Bookhout, ed. *Research and management techniques for wildlife and habitats*, 5th edn. The Wildl. Soc., Bethesda, Maryland.
- Sharp, D. E., and J. T. Lokemoen. 1980. A remote-controlled firing device for cannon net traps. *J. Wildl. Manage.* 44:896-898.

### Chapter 3

#### Evening Flights of Female Northern Pintails From a Major Roost Site\*

##### INTRODUCTION

Many waterfowl species concentrate on refuges in winter, particularly during hunting seasons (Chabreck et al. 1989, Baldassarre and Bolen 1994). Refuging theory predicts that individuals concentrated within a central place will increase distance traveled over time as easily accessed food resources near the central place are depleted (Hamilton and Watt 1970). Flight is energetically expensive for birds, with costs estimated as high as 15 times basal metabolic rate (BMR; King 1974, Prince 1979). Consequently, individuals roosting on refuges which provide limited feeding opportunities must weigh benefits of roosting on refuges (e.g., increased survival) against foraging flight costs.

Northern pintails (Anas acuta, hereafter pintails) roost diurnally on Lacassine National Wildlife Refuge (NWR) in southwestern Louisiana during winter, with peak numbers reaching 285,000 birds (Yakupzack 1988). Seventy-five percent of waterfowl use on Lacassine NWR occurs between 1 November and 31 January, with largest numbers found during hunting seasons (Tamisier 1976, Yakupzack 1988). Pintails spend little time feeding on the refuge, but rather spend over 8 h sleeping during daytime hours (Tamisier 1976). Most pintails depart Lacassine NWR after sunset, apparently to forage nocturnally in rice (Oryza sativa) fields to the north (Tamisier 1976, Yakupzack 1988).

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I used radio-telemetry to investigate three parameters of evening flights of female pintails using Lacassine NWR as a daytime refuge: flight distance, flight duration, and departure time. I examined variation in flight parameters attributable to winter (1991-1992 or 1992-1993), female age, and date within wintering period. I further tested for variation in flight parameters in relation to hunting versus non-hunting seasons, and variation in departure time in relation to environmental conditions. Finally, I examined whether temporal variations in flight distance and duration were consistent with predictions of refuging theory.

## **STUDY AREA AND METHODS**

My study area included an area extending 80 km from the perimeter of Lacassine Pool (29°58'N, 92°54'W), a permanently flooded 6793-ha freshwater impoundment located on Lacassine NWR (U. S. Fish and Wildlife Service [USFWS] 1977, Yakupzack 1988). The refuge is located in a transition zone marked by extensive marsh to the south and agricultural lands to the north (Tamisier 1976, Chabreck et al. 1989). The area was described in detail by Rootes (1989).

I captured pintails from 30 September-27 October 1991 and from 4-25 October 1992 by rocket-netting over bait (Cox and Afton 1994). I aged females as immature or adult using cloacal and tail- and wing-feather characteristics (Hochbaum 1942, Carney 1964, Duncan 1985). I attached 21-g backpack-type radio transmitters (Dwyer 1972; Advanced Telemetry Systems, Inc., Isanti, MN) that had expected lives of 150 days and maximum ground-to-ground ranges of 7-9 km using truck-mounted, four-element, null-peak antennas. My goal was to radio-tag equal numbers of immature and adult females

each winter, but I consistently captured and tagged greater numbers of adults. In the final rocket-net shot in 1991-1992, numbers of captured immatures exceeded pre-planned sample sizes, and I randomly selected immatures to tag. In the final rocket-net shot in 1992-1993, I radio-tagged all captured immatures, and randomly selected adults to tag. I radio-tagged 155 females (58 immatures and 97 adults) in 1991-1992, and 152 females (44 immatures and 108 adults) in 1992-1993.

From 20 November 1991-9 February 1992 and 30 October 1992-22 February 1993, I obtained late afternoon (16:00-17:30 CST) locations of radio-tagged females on Lacassine NWR. I estimated locations by triangulation (Samuel and Fuller 1994) from two 11-m permanent towers, each supporting nine-element unidirectional antennas. I selected a maximum of three individuals daily from radio-tagged females located on Lacassine NWR (range of radio-tagged females on Lacassine NWR = 1-80), and continuously monitored selected birds for aerial movements from 0.5 h before sunset until 1 h after sunset. I followed females flying to their nocturnal destinations (hereafter direct observations) and then estimated their locations by triangulation using truck-mounted antenna systems. I used Lenth's maximum-likelihood estimator (MLE) to produce point locations in Universal Transverse Mercator system coordinates from all triangulations (White and Garrott 1990). I calculated MLEs on-site using laptop computers and LOCATE II software (Nams 1990). I estimated linear distance moved from origin and destination coordinates. I recorded times of departure and arrival to the nearest min.

In selecting birds to monitor, I maximized the number of individuals included in the study and temporally segregated successive observations on individuals. I first divided winters into five time periods: (1) pre-hunting season (30 October-20 November 1992), (2) first hunting season (16 November-6 December 1991 and 21 November-5 December 1992), (3) time between split hunting seasons (7-27 December 1991 and 6-25 December 1992), (4) second hunting season (28 December 1991-5 January 1992 and 26 December 1992-9 January 1993), and (5) post-hunting season (6 January-9 February 1992 and 10 January-22 February 1993). I then preferentially selected in order: (1) birds not monitored previously, (2) birds not monitored previously during the present time period, and (3) birds monitored previously during the present time period.

During 1-24 January 1992 and 6 November 1992-9 February 1993, I also indirectly estimated flight distance of radio-tagged females. I did this by scanning for a randomly selected subset of radio-tagged birds (30-80) from permanent towers on Lacassine NWR during late afternoon (16:00-17:30), and then relocating them later that night (19:00-05:00). I used fixed-winged aircraft equipped with a pair of two- or four-element Yagi antennas to assist in locating birds (Gilmer et al. 1981). I estimated nocturnal locations using vehicle-mounted telemetry systems as described above, except for one individual which I located aurally in an inaccessible area.

For analysis, I assumed that radio-tagged females were independent. I examined this assumption by estimating the frequency at which radio-tagged females flew in the same flock during direct observations. I liberally assumed that females flew in the same flock if they departed and arrived within 5 min of each other at destinations within 1 km.

I considered three response variables for analysis: flight distance (km), flight duration (min), and departure time (min after sunset). For flight distance, I analyzed direct and indirect observations separately. I used repeated-measures, mixed-model ANCOVA (PROC MIXED, SAS 1996) with maximum likelihood estimation to assess relationships of response variables to several explanatory variables. I considered winter (1991-1992 or 1992-1993) and age (immature or adult) as fixed effects, and date within wintering period (days since 29 October; hereafter date) as the covariate. I tested all interactions in initial models, including those with date, to assess homogeneity of slopes (SAS 1991). The number of observations per individual varied greatly because of mortality and emigration from the study area (Cox, unpubl. data). Repeated measures also were irregularly spaced in time because the probability of a bird being monitored was conditional upon its survival and presence on Lacassine NWR in late afternoon. Therefore, I used likelihood ratio tests (Wolfinger 1992) from full models to evaluate the matrix structure of repeated measures as either simple (no correlation among repeated measures) or compound symmetry (equal correlation among successive repeated measures; SAS 1996), and maintained the appropriate structure throughout model-fitting. I used stepwise model-fitting procedures with -2 log likelihood tests as criteria for deleting terms from models for each response variable (Wolfinger 1992), beginning with the highest-order interactions.

Tamisier (1976) indicated that departure times of waterfowl from Lacassine NWR may be influenced by environmental effects, primarily illumination and wind conditions. Consequently, I categorized cloud cover on-site each day at 0.5 h before

sunset as: (1) clear (CLR) -- no clouds present, (2) partly cloudy to partly sunny (PCLPSN) -- 1-99% cloud cover, or (3) overcast (OVC) -- 100% cloud cover. I concurrently classified wind velocity as: (1) light --  $\leq 8 \text{ km h}^{-1}$ , or (2) heavy --  $> 8 \text{ km h}^{-1}$ . I classified moon presence or absence from 0.5 h before sunset until 1 h after sunset using lunar phase, and rise and set times (Hoffman 1991-1993). I was unable to include environmental variables in the ANCOVA of departure time because of small samples relative to explanatory variables. Thus, I examined the influence of environmental variables on departure time in a separate ANOVA (PROC MIXED, SAS 1996). I was able to treat this analysis as a completely randomized design (Montgomery 1991) because repeated measures of departure times in my original ANCOVA were not correlated ( $\rho = 0.68$ ). I used variation due to trials (date treated as a class variable rather than a continuous covariate) as the error term for testing environmental effects, and considered variation due to birds as sampling error. I initially included all interactions among environmental variables, and eliminated terms as described above using -2 log likelihood tests (Wolfinger 1992). I then used residuals from this final fitted model to refit my original ANCOVA model. This approach allowed me to test for effects of age, winter, and date after controlling for environmental effects. To test for possible effects on departure time due to duck hunting, I replaced date with a categorical variable, hunting presence (first and second duck hunting seasons) or absence (pre-hunting season, time between split hunting seasons, and post-hunting season), and refit the model. I hypothesized that if duck hunting was an important factor influencing departure time, departure times should be similar between first and second hunting

seasons, and among the three non-hunting seasons, but dissimilar between hunting and non-hunting time periods. I tested for hunting effects on flight distance (direct observations) and duration by replacing date with the categorical variable denoting presence or absence of duck hunting in final fitted models. I compared least-square means of significant ( $P < 0.05$ ) effects from all final models using Fisher's Protected LSD (PDIF option; SAS 1996).

For flight distance and duration, initial analyses indicated that residuals were not normally distributed. I subsequently applied square-root and natural logarithm transformations to flight distance and duration, respectively, to achieve normality. I omitted from analyses birds that failed to take flight ( $n = 9$  direct and  $n = 1$  indirect). On seven occasions, I temporarily lost birds during monitored flights, but later located them to obtain flight distance. Pintails departed Lacassine NWR prior to sunset on three of 196 (2%) occasions. I subsequently omitted these observations (20, 11, and 8 minutes before sunset) from analyses of departure time to meet normality assumptions.

I used Aschoff and Pohl's (1970) equation for non-passerines to estimate daily BMR ( $\text{kcal day}^{-1}$ ) of adult female pintails ( $\bar{x} \pm \text{SE}$  body mass at capture =  $765 \pm 5.8$  g,  $n = 234$ , Cox, unpubl. data), assuming equal lengths of active and rest periods. I estimated energetic cost of flight by multiplying flight duration by 12 times BMR ( $\text{kcal}$ ; King 1974, Robbins 1993). To express flight costs in terms of amount of rice necessary to meet metabolic costs, I used  $3.34 \text{ kcal g}^{-1}$  as an estimate of true metabolizable energy for rice (Reinecke et al. 1989).

## RESULTS

Pintails departed Lacassine NWR between 0.5 h before sunset and 1 h after sunset on 196 of 205 (96%) directly monitored trials. Females rarely traveled together in the same flock (1 of 164 [0.6%] possible trials). On 189 occasions, I attempted to locate pintails on Lacassine NWR the day after their evening flights were monitored, and found that they had returned to Lacassine NWR from nocturnal destinations on 135 (71%) occasions.

### Direct Observations of Flight Distance

I analyzed 198 flights of 108 females. Compound symmetry provided a better fit to these data than did a simple structure (likelihood ratio test from full model,  $P < 0.01$ ), indicating that repeated measurements on birds were correlated. The final fitted model indicated that flight distance increased with date ( $P < 0.001$ ), and that age differences in distance were not consistent between winters (age-by-winter interaction,  $P < 0.005$ ; Table 3.1). Flight distance increased at an estimated rate of  $0.011 \pm 0.003 \text{ km}^{0.5}$  per day during winter ( $n = 198$ ; Table 3.1). When I replaced date with hunting presence or absence, I found that flight distance did not differ ( $P = 0.58$ ) in relation to duck hunting.

### Indirect Observations of Flight Distance

I analyzed 176 observations of 91 females. Repeated measures of individual females also were correlated in this analysis (likelihood ratio test from full model,  $P < 0.01$ ). The final fitted model included only the date-by-winter interaction ( $P < 0.001$ ). Flight distance did not vary with date in 1991-1992 (Table 3.1), but increased  $0.022 \pm 0.004 \text{ km}^{0.5}$  per day in 1992-1993 ( $n = 176$ ; Table 3.1).

Table 3.1. Estimated intercepts (a) and slopes (b) ( $\pm$  SE) from final fitted mixed-model ANCOVAs describing relationships between response variables (Y; flight distance, flight duration, and departure time) and date within wintering period (X) for age and/or winter combinations for female northern pintails departing Lacassine NWR.

Response <sup>1</sup>	a <sup>2</sup>	b	p <sup>3</sup>
Flight distance (km <sup>0.05</sup> )			
Direct observations			
Immatures 1991-1992	2.60 $\pm$ 0.32 A	0.011 $\pm$ 0.003	<0.001
Adults 1991-1992	3.64 $\pm$ 0.27 B	0.011 $\pm$ 0.003	<0.001
Immatures 1992-1993	3.62 $\pm$ 0.27 B	0.011 $\pm$ 0.003	<0.001
Adults 1992-1993	3.14 $\pm$ 0.22 AB	0.011 $\pm$ 0.003	<0.001
Indirect observations			
1991-1992	6.78 $\pm$ 1.53 A	-0.036 $\pm$ 0.021	0.09
1992-1993	2.86 $\pm$ 0.21 B	0.022 $\pm$ 0.004	<0.001
Flight duration (ln min)			
Immatures 1991-1992	2.72 $\pm$ 0.20 A	0.004 $\pm$ 0.002	0.049
Adults 1991-1992	3.17 $\pm$ 0.17 B	0.004 $\pm$ 0.002	0.049
Immatures 1992-1993	3.03 $\pm$ 0.16 AB	0.004 $\pm$ 0.002	0.049
Adults 1992-1993	2.80 $\pm$ 0.14 A	0.004 $\pm$ 0.002	0.049
Departure time (min after sunset) <sup>4</sup>			
1991-1992	21.98 $\pm$ 1.23	0.004 $\pm$ 0.020	0.83
1992-1993	21.98 $\pm$ 1.23	-0.047 $\pm$ 0.020	0.019

<sup>1</sup>To obtain untransformed predicted values for an age and/or winter group on a particular date, calculate  $a + b(X)$  and either square or antilog the result for flight distance and duration, respectively.

(table con'd)



<sup>2</sup>Intercepts within flight parameter and type of observation groups followed by the same letter do not differ ( $\underline{P} > 0.05$ ) as determined by Fisher's LSD.

<sup>3</sup> $\underline{P}$ -value testing slope  $(b) = 0$  given  $Y = a + b(X)$ .

<sup>4</sup>Estimates from mixed-model ANCOVA testing for age, winter, and date effects before controlling for environmental variables (see Methods).

## Flight Duration

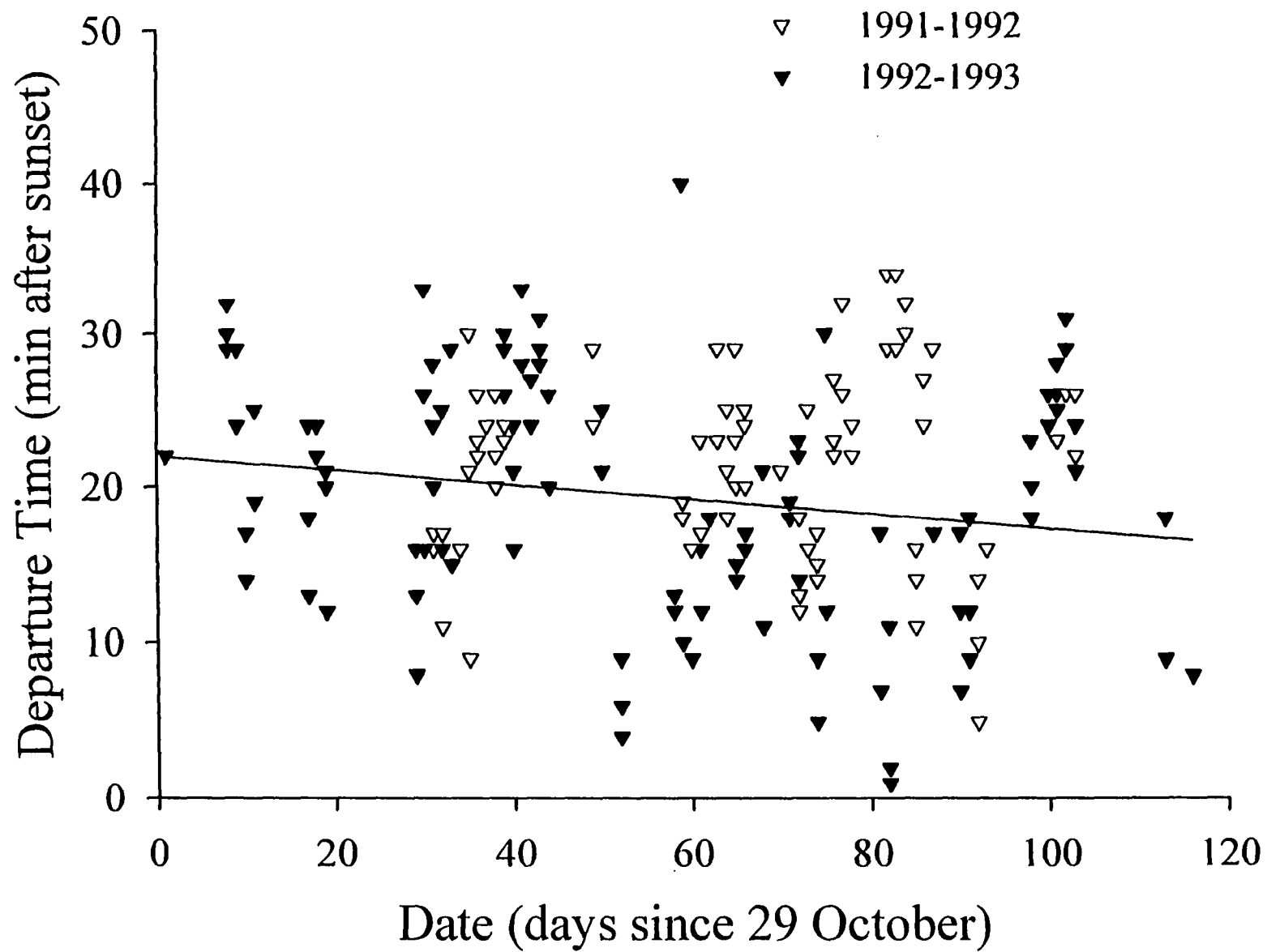
I analyzed durations of 191 flights of 106 females. Compound symmetry described the relationship among repeated measurements better than simple structure (likelihood ratio test from full model,  $P < 0.005$ ), indicating that successive observations of individuals were correlated. My final model indicated that flight duration increased with date ( $P < 0.05$ ) and that age differences in duration were not consistent between winters (age-by-winter interaction,  $P < 0.05$ ; Table 3.1). Flight duration increased  $0.004 \pm 0.002$  (ln min) per day during winter ( $n = 191$ ; Table 3.1). When I replaced date with hunting presence or absence, I found that flight duration did not differ ( $P = 0.48$ ) in relation to duck hunting.

## Departure Time

I analyzed 193 departure times of 106 individuals. Compound symmetry did not describe the relationship among repeated measures better than simple structure (likelihood ratio test from full model,  $P = 0.68$ ), indicating that repeated observations on individuals were not correlated. My final fitted model indicated that departure time varied with date, but the relationship was not consistent between winters (date-by-winter interaction,  $P < 0.005$ ). Females departed earlier in relation to sunset as winter progressed in 1992-1993, but departure times did not vary with date in 1991-1992 (Table 3.1, Fig. 3.1).

My analysis of departure times in relation to environmental variables indicated that observations made on a given day were correlated ( $P < 0.005$  from full model); individual females apparently adjusted departure times similarly to conditions specific to

Figure 3.1. Relationship of departure time (min after sunset) of female northern pintails roosting on Lacassine National Wildlife Refuge to date within wintering period for each winter. Regression equation (winter 1992-1993 only) is given in Table 3.1.



a given evening. The final fitted model indicated that differences in departure time due to moon phase were not consistent among levels of cloud cover (moon-by-cloud cover interaction,  $P < 0.05$ ) and that departure times differed between levels of wind velocity ( $P < 0.005$ ). Females generally departed earlier as cloud cover increased (Table 3.2). Under PCLPSN conditions, departures were 3.4 min earlier, on average, on moonless evenings as compared to moonlit evenings (Table 3.2). Females departed Lacassine NWR earlier on evenings when winds were heavy ( $LS \bar{x} \pm SE = 18.0 \pm 1.0$  min post-sunset) than when winds were light ( $LS \bar{x} \pm SE = 21.7 \pm 0.6$  min post-sunset).

My final fitted model, using residuals from the analysis of environmental variables, indicated that departure times differed between ages ( $P < 0.05$ ). Date and winter main effects, and all interactions, were not significant ( $P > 0.05$  for all tests). After controlling for environmental effects, immatures departed Lacassine NWR 1.3 min earlier, on average, than did adults. When I replaced date with hunting presence or absence and refit the model, I again adopted a final fitted model that contained only age effects. After controlling for environmental effects, departure times did not differ ( $P = 0.66$ ) between hunting and non-hunting seasons, and all interactions were not significant ( $P > 0.05$  for all tests). These results indicate that the earlier apparent association between departure time and date in 1992-1993 was caused primarily by a higher proportion of cloudy, windy days from mid-December through January in 1992-1993 than in 1991-1992 (dates 50-90 in Figs. 3.2b and 3.2d).

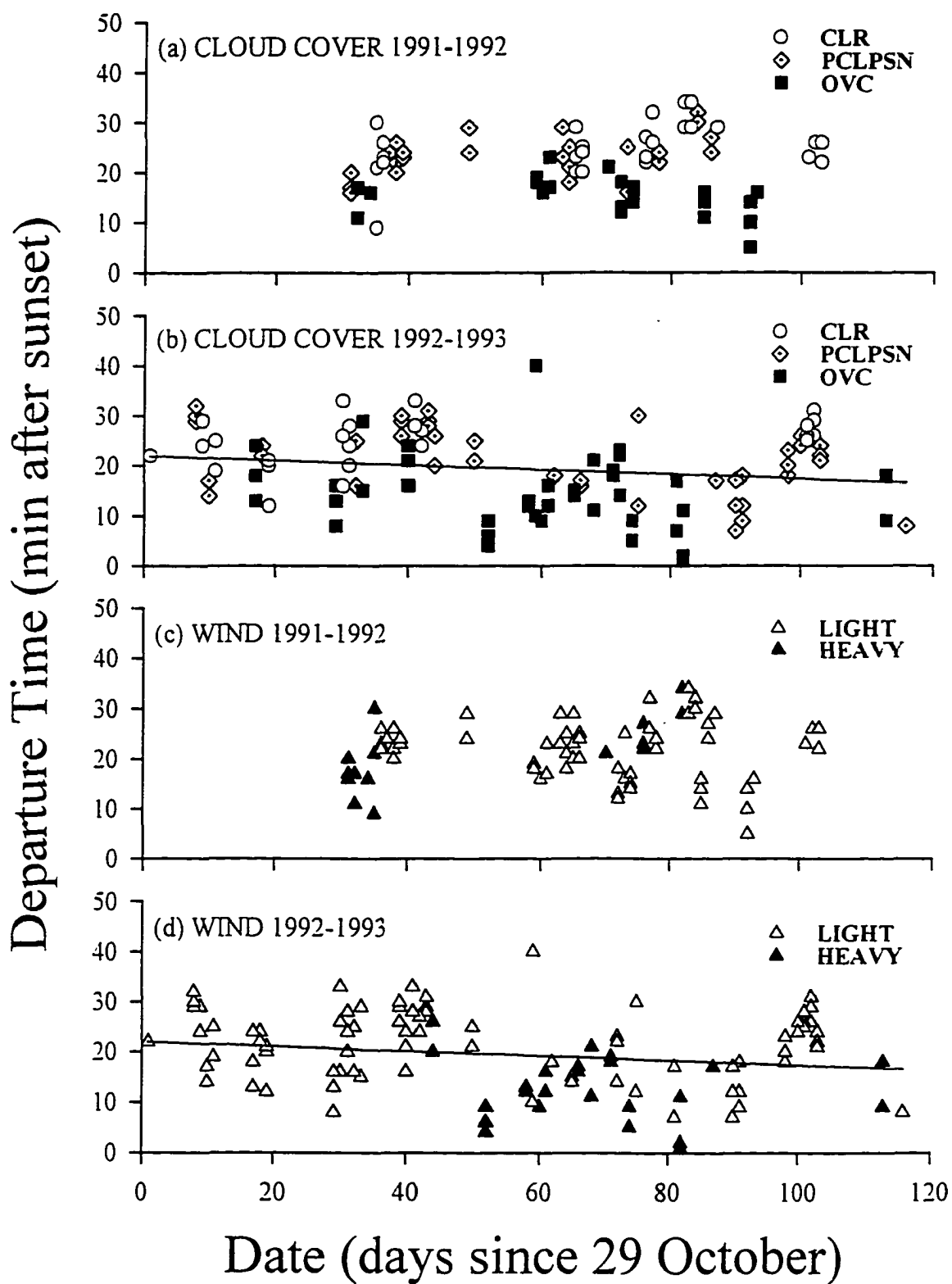
Table 3.2. Least-square means  $\pm$  SE of departure time (min after sunset) by moon and cloud cover categories for female northern pintails departing Lacassine NWR during winters 1991-1992 and 1992-1993.

Moon	Cloud Cover <sup>1</sup>	Estimate <sup>2</sup>
Not Present	CLR	23.5 $\pm$ 1.4 A
Not Present	PCLPSN	22.6 $\pm$ 1.3 A
Not Present	OVC	13.1 $\pm$ 1.1 B
Present	CLR	24.6 $\pm$ 1.2 A
Present	PCLPSN	19.2 $\pm$ 1.1 C
Present	OVC	10.5 $\pm$ 1.8 B

<sup>1</sup>CLR = clear, PCLPSN = partly cloudy to partly sunny, and OVC = overcast.

<sup>2</sup>Means followed by the same letter do not differ ( $P > 0.05$ ).

Figure 3.2. Relationship of departure time (min after sunset) of female northern pintails roosting on Lacassine National Wildlife Refuge to date within wintering period for each winter. Graphs a and b show levels of cloud cover, while graphs c and d show levels of wind velocity. Fitted regression line on graphs b and d is from the date-by-winter effect from mixed-model ANCOVA (see text and Table 3.1).





## DISCUSSION

My analysis of direct observations indicated that predicted one-way evening flight distances for various age and winter combinations ranged from 8.7 to 24.4 km, and predicted one-way evening flight durations ranged from 16.4 to 32.9 min. Females returned to Lacassine NWR following evening flights at a high rate (71%). Furthermore, my estimate of return rate probably is conservative because I selected birds for monitoring that habitually roosted on Lacassine NWR less often than expected by chance (see Methods). Assuming that return flights were similar in duration to departing flights, pintails spent 32.8-65.8 min day<sup>-1</sup> in flight to and from the refuge. I estimate BMR of adult females to be 67.6 kcal day<sup>-1</sup>, and foraging flight costs to be 18.4-36.8 kcal day<sup>-1</sup>. Therefore, transit costs were equivalent to 27-54% of BMR, and pintails would have to consume 5.5-11.0 g of additional rice per day to meet these costs.

Estimated daily energy expenditure (DEE) and food consumption by female pintails in California from 15 October-15 February ranged from 177-232 kcal and 51-69 g of rice and moist-soil seeds, respectively (M. Miller, unpubl. data). Assuming that these values are similar for females in southwestern Louisiana, transit costs were equivalent to 7-19% of DEE and 8-20% of total daily intake. The maximum one-way difference in flight duration among ages and winters was 12.8 min (adults versus immatures on 9 February 1992), which amounts to 14.4 kcal or 4.3 g of rice per day for transit costs. Using 58-61 g as an estimate of daily food consumption during 15 January-15 February (M. Miller, unpubl. data), maximum differential flight duration among ages and winters represents 7% of total daily food intake. Although these

estimated costs do not seem excessive, I believe that they are not trivial. My estimates of flight distance and duration for female pintails were greater than for most other species of wintering waterfowl, although comparative studies of flight duration are limited (Table 3.3). When additional flight activity due to disturbance is considered, which may be substantial (Tamisier 1976, Chabreck et al. 1989, Rave and Cordes 1993), it is likely that energy expenditure for flight constitutes an important component of DEE for pintails roosting on Lacassine NWR.

I conclude that departure times of female pintails are influenced primarily by environmental conditions. This conclusion is based on several results: (1) departure times measured on the same individual on different dates were not correlated, (2) departure times of different individuals measured on the same evening were correlated, and (3) after controlling for environmental effects, departure times did not differ between winters or among dates, but differed slightly (1.3 min) between ages. The significant cloud cover-by-moon interaction suggests that light conditions in late evening serve as a proximate cue for departures. Although not quantified, Tamisier (1976) reported that bright moonlight was responsible for delaying departure times of pintails and green-winged teal (*Anas crecca*) from Lacassine NWR. In Texas, evening foraging flights of mixed flocks of ducks, primarily pintails and green-winged teal, began 10-15 min earlier than normal under completely overcast conditions (Baldassarre and Bolen 1984). Wood ducks (*Aix sponsa*) and scaup (*Aythya spp.*) also delay evening flights with decreasing cloud cover (Blackbill 1952, Hein and Haugen 1966, Tabberer et al. 1973, Scott and Parr 1978).

Table 3.3. Mean flight distances and durations reported for wintering waterfowl.

Species	Distance (km)	Duration (min)	Authority
<u>Anser caerulescens</u>	23.0 <sup>a</sup>	78.0	Davis et al. 1989
<u>Anser caerulescens</u>	----	25.1 <sup>b</sup>	Frederick and Klaas 1982
<u>Branta canadensis</u>	----	9.4	Austin and Humburg 1992
<u>Aix sponsa</u>	1.4	----	Parr et al. 1979
<u>Aix sponsa</u>	0.6	----	Costanzo et al. 1983
<u>Anas rubripes</u>	5.6 <sup>a</sup>	----	Morton et al. 1989
<u>Anas penelope</u>	10.0-20.0+ <sup>a</sup>	----	Lebret 1959
<u>Anas platyrhynchos</u>	6.4-40.0 <sup>a</sup>	7.4-34.0 <sup>a</sup>	Jorde et al. 1983
<u>Anas acuta</u>	17.4-48.8 <sup>a</sup>	32.8-65.8 <sup>a</sup>	This study
<u>Aythya valisineria</u>	23.4 <sup>a</sup>	----	Howerter 1990

<sup>a</sup>Estimate restricted to daily flights between roosts and feeding sites.

<sup>b</sup>Calculated from estimates presented in Frederick and Klaas (1982) assuming mean of 11 h daylight in Nebraska from October-December.

Females generally departed Lacassine NWR earlier as wind velocity increased. These findings are consistent with those of Tamisier (1976), who reported earlier departure times for pintails and green-winged teal from Lacassine NWR on windy, cloudy, or rainy days, and Miller (1985), who noted earlier evening flights of pintails from refuges in California on rainy, windy days. Windy conditions in winter are associated with passage of cold fronts, which, in turn, are characterized by marked changes in barometric pressure and surface temperatures (Schroeder and Buck 1970). I speculate that earlier departures under windy conditions allow pintails additional foraging time in preparation for, or in response to, increased thermoregulatory costs.

Flight parameters did not differ between hunting and non-hunting seasons. However, because females consistently departed well after sunset throughout winter, even prior to initiation of hunting, pintails really were not exposed to hunting during evening flights. My results of no hunting effects would have been more conclusive if I had found that pintails maintained similar pre-sunset departure times between non-hunting and hunting seasons. Thus, I am reluctant to conclude, as did Tamisier (1976), that hunting does not influence activity patterns of pintails roosting on Lacassine NWR. Pintails may adopt post-sunset departures in response to disturbance from agricultural harvesting, which is high in October when pintails arrive in the study area (Bagent et al. 1987), or in anticipation of, rather than in response to, shooting pressure. Pintails roosting on refuges in the Sacramento Valley of California, which arrive there 6-8 weeks earlier than in southwestern Louisiana, adjusted departure times from pre-sunset prior to hunting to post-sunset once hunting began, and maintained post-sunset departures

thereafter (Fig. 7 in Miller 1985). Miller et al. (1995) speculated that high survival of adult female pintails in the Sacramento Valley of California was due, in part, to reacquaintance with refuge areas between arrival and hunting seasons. Whether post-sunset departure from refuge areas (and nocturnal feeding) is a learned response to disturbance that is retained between winters or a naturally occurring phenomenon (Tamisier 1976) can be tested only with rigorous, long-term, experimental (non-observational) research.

Flight distance and duration increased among dates within winters for all combinations of female ages, winters, and types of observations, except indirect observations of flight distance in 1991-1992. Using indirect observations, my analysis of the relationship between flight distance and date in 1991-1992 had reduced power because of the short time interval (24 days) over which I obtained these observations. Restricted observation dates in 1991-1992 also decreased power for testing main effects and interactions involving winters using indirect observations. The agreement between direct and indirect observations of flight distance in 1992-1993 is consistent with my observations (Cox, unpubl. data) that female pintails infrequently made additional flights at night, and suggests that reliable estimates of flight distance could be obtained using less labor-intensive indirect methods.

My results of increased flight distance and duration during winters are consistent with predictions of refuging theory when food resources are depleted preferentially near the central place or core area (Hamilton and Watt 1970). However, hunting leases and commercial hunting operations are more prevalent near Lacassine NWR than in more

distant (>20 km) portions of the study area (R. Helm, LDWF, pers. comm. and R. Cox, unpubl. data). Because agricultural fields leased to hunters often are flooded artificially to attract ducks, nearby areas probably are more likely to be flooded earlier in winter than more distant areas. Thus, greater flight distance and duration by pintails later in winters may be in response to availability of naturally flooded habitat from heavy rains in December and January rather than food depletion. Alternatively, increases in flight distance and duration within winter may result partly from increased zugunruhe (nocturnal restlessness; Farner 1955) associated with spring migration. Rigorous testing of refuging theory would require temporal and spatial quantification or manipulation of food availability throughout the range of distances flown, which was beyond the scope of my study. I conclude that while my results are consistent with predictions of refuging theory, alternative hypotheses could explain these findings.

Pintails flew relatively long distances to obtain food, suggesting that potential benefits of roosting on Lacassine NWR were great. Accordingly, transit costs of pintails and other refuging waterfowl, along with evaluation of relative importance of specific benefits of roosting on refuges, should receive further research. If food availability on and near refuges is a potentially important determinant of flight distance and duration, flight energetics may become an increasingly important component of DEE of refuging waterfowl in the future if habitat losses continue on wintering areas. I recommend that proximity of refuges and feeding areas should be considered in management plans for pintails and other wintering waterfowl.

## LITERATURE CITED

- Aschoff, J., and H. Pohl. 1970. Der ruheumsatz von Vögeln als Funktion der tageszeit und der Körpergrösse. *J. Ornithol.* 111:38-47.
- Austin, J. E., and D. D. Humburg. 1992. Diurnal flight time of wintering Canada geese: consideration of refuges and flight energetics. *Prairie Nat.* 24:21-31.
- Bagent, J. L., D. M. Brandon, R. T. Dunand, D. E. Groth, C. A. Hollier, J. A. Musick, M. C. Rush, C. M. Smith, T. P. Zacharias, P. K. Bollich, D. L. Deason, J. F. Fowler, W. A. Hadden, S. Linscombe, K. S. Mckenzie, J. F. Robinson, D. E. Sanders, and H. D. Traylor. 1987. Rice production handbook. Louisiana Coop. Extension Serv. Publ. 2321, Baton Rouge. 63pp.
- Baldassarre, G. A., and E. G. Bolen. 1984. Field-feeding ecology of waterfowl wintering on the Southern High Plains of Texas. *J. Wildl. Manage.* 48:63-71.
- Baldassarre, G. A., and E. G. Bolen. 1994. Waterfowl ecology and management. John Wiley and Sons, New York. 609pp.
- Blackbill, H. 1952. Light intensity and waterfowl flight; preflight activities. *Wilson Bull.* 64:242-244.
- Carney, S. M. 1964. Preliminary keys to waterfowl age and sex identification by means of wing plumage. *U. S. Fish and Wildl. Serv. Spec. Sci. Rep. Wildl.* 82. 47pp.
- Chabreck, R. H., T. Joanen, and S. L. Paulus. 1989. Southern coastal marshes and lakes. Pages 249-277 in L. M. Smith, R. L. Pederson, and R. M. Kaminski, eds. *Habitat management for migrating and wintering waterfowl in North America.* Texas Tech Univ. Press, Lubbock.
- Costanzo, G. R., T. T. Fendley, and J. R. Sweeney. 1983. Winter movements and habitat use of wood ducks in South Carolina. *Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies* 37:67-78.
- Cox, R. R., Jr., and A. D. Afton. 1994. Portable platforms for setting rocket nets in open-water habitats. *J. Field Ornithol.* 65:551-555.
- Davis, S. E., E. E. Klaas, and K. J. Koehler. 1989. Diurnal time-activity budgets and habitat use of lesser snow geese (*Anser caerulescens*) in the middle Missouri River valley during winter and spring. *Wildfowl* 40:45-54.

- Duncan, D. C. 1985. Differentiating yearling from adult northern pintails by wing-feather characteristics. *J. Wildl. Manage.* 49:576-579.
- Dwyer, T. J. 1972. An adjustable radio-package for ducks. *Bird-Banding* 43:282-284.
- Farner, D. S. 1955. The annual stimulus for migration: experimental and physiologic aspects. Pages 198-237 in A. Wolfson, ed. *Recent studies in avian biology*. Univ. of Illinois Press, Urbana.
- Frederick, R. B., and E. E. Klaas. 1982. Resource use and behavior of migrating snow geese. *J. Wildl. Manage.* 46:601-614.
- Gilmer, D. S., L. M. Cowardin, R. L. Duval, L. M. Mechlin, C. W. Shaiffer, and V. B. Kuechle. 1981. Procedures for the use of aircraft in wildlife biotelemetry studies. U. S. Fish and Wildl. Serv. Resour. Publ. 140. 19pp.
- Hamilton, W. J., III, and K. E. F. Watt. 1970. Refuging. *Annu. Rev. Ecol. Syst.* 1:263-286.
- Hein, D., and A. O. Haugen. 1966. Illumination and wood duck roosting flights. *Wilson Bull.* 78:301-308.
- Hochbaum, H. A. 1942. Sex and age determination of waterfowl by cloacal examination. *Trans. North Am. Wildl. Conf.* 7:299-307.
- Hoffman, M. S., editor. 1991-1993. *The world almanac and book of facts*. Pharos Books, New York.
- Howerter, D. W. 1990. Movements and bioenergetics of canvasbacks wintering in the Upper Chesapeake Bay. M.S. Thesis, Virginia Polytechnic Inst., Blacksburg. 80pp.
- Jorde, D. G., G. L. Krapu, and R. D. Crawford. 1983. Feeding ecology of mallards wintering in Nebraska. *J. Wildl. Manage.* 47:1044-1053.
- King, J. R. 1974. Seasonal allocation of time and energy resources in birds. Pages 4-85 in R. A. Paynter, Jr., ed. *Avian energetics*. Nuttall Ornithol. Club, Cambridge, MA.
- Lebret, T. 1959. De dagelijkse verplaatsingen tussen dagverblijf en nachtelijk voedselgebied big smienten, Anas penelope L., in enige terreinen in het lage midden van Friesland. *Ardea* 47:199-210.



- Miller, M. R. 1985. Time budgets of northern pintails wintering in the Sacramento Valley, California. *Wildfowl* 36:53-64.
- Miller, M. R., J. P. Fleskes, D. L. Orthmeyer, W. E. Newton, and D. S. Gilmer. 1995. Survival of adult female northern pintails in Sacramento Valley, California. *J. Wildl. Manage.* 59:478-486.
- Montgomery, D. C. 1991. Design and analysis of experiments, Third ed. John Wiley and Sons, New York. 649pp.
- Morton, J. M., R. L. Kirkpatrick, M. R. Vaughan, and K. F. Stauffer. 1989. Habitat use and movements of American black ducks in winter. *J. Wildl. Manage.* 53:390-400.
- Nams, V. O. 1990. Locate II: user's guide. Pacer. Truro, Nova Scotia, Canada. 84pp.
- Parr, D. E., M. D. Scott, and D. D. Kennedy. 1979. Autumn movements and habitat use by wood ducks in southern Illinois. *J. Wildl. Manage.* 43:102-108.
- Prince, H. H. 1979. Bioenergetics of postbreeding dabbling ducks. Pages 103-117 in T. A. Bookhout, ed. Waterfowl and wetlands - an integrated review. Proc. 1977 Symp., North Cent. Sect., The Wildl. Soc., Madison, Wisconsin.
- Rave, D. P., and C. L. Cordes. 1993. Time-activity budget of northern pintails using nonhunted rice fields in southwest Louisiana. *J. Field Ornithol.* 64:211-218.
- Reinecke, K. J., R. M. Kaminski, D. J. Moorhead, J. D. Hodges, and J. R. Nassar. 1989. Mississippi Alluvial Valley. Pages 203-247 in L. M. Smith, R. L. Pederson, and R. M. Kaminski, eds. Habitat management for migrating and wintering waterfowl in North America. Texas Tech Univ. Press, Lubbock.
- Robbins, C. T. 1993. Wildlife feeding and nutrition, Second ed. Academic Press, San Diego. 352pp.
- Rootes, W. L. 1989. Behavior of the American alligator in a Louisiana freshwater marsh. Ph.D. Thesis, Louisiana State Univ., Baton Rouge.
- Samuel, M. D., and M. R. Fuller. 1994. Wildlife radiotelemetry. Pages 370-418 in T. A. Bookhout, ed. Research and management techniques for wildlife and habitats. The Wildl. Soc., Bethesda, MD.

- SAS Institute Inc. 1991. SAS system for linear models, Third ed. SAS Institute Inc., Cary, NC. 329pp.
- SAS Institute Inc. 1996. SAS/STAT software: changes and enhancements through release 6.11. SAS Institute Inc., Cary, NC. 1080pp.
- Schroeder, M. J., and C. C. Buck. 1970. Fire weather... a guide for application of meteorological information to forest fire control operations. U. S. Dept. of Ag., U. S. Forest Serv. Ag. Handbook 360. 229pp.
- Scott, M. D., and D. E. Parr. 1978. Environmental factors affecting wood duck roosting flights in southern Illinois. Trans. Ill. State Acad. Sci. 71:72-80.
- Tabberer, D. K., J. D. Newsom, and P. E. Schilling. 1973. Law enforcement implications of a Wood Duck roost study in Louisiana. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 27:318-324.
- Tamisier, A. 1976. Diurnal activities of green-winged teal and pintail wintering in Louisiana. Wildfowl 27:19-32.
- U. S. Fish and Wildlife Service. 1977. Lacassine National Wildlife Refuge Master Plan. U. S. Dep. Inter., Fish and Wildl. Serv., Washington, DC. 4pp.
- White, G. C., and R. A. Garrott. 1990. Analysis of wildlife radio-tracking data. Academic Press, San Diego, California. 383pp.
- Wolfinger, R. 1992. A tutorial on mixed models. SAS Institute Inc., Cary, NC. 38pp.
- Yakupzack, P. 1988. Wildlife disease contingency plan. Lacassine Nat. Wildl. Ref., Lake Arthur, LA. 23pp.

## **Chapter 4**

### **Use of Habitats by Female Northern Pintails Wintering in Southwestern Louisiana**

#### **INTRODUCTION**

The continental pintail breeding population in 1995 was 39% below the long-term average, and 56% below goals outlined by the North American Waterfowl Management Plan (NAWMP; U.S. Fish and Wildlife Service [USFWS] and Canadian Wildlife Service [CWS] 1986, USFWS and CWS 1995). Although drought and habitat loss on breeding areas probably has influenced population declines (Ducks Unlimited, Inc. 1990), winter habitat conditions are positively correlated with annual changes in pintail breeding population sizes the following spring (Raveling and Heitmeyer 1989). The largest concentrations of pintails wintering in the Central and Mississippi Flyways are found along the Gulf Coasts of Texas and southwestern Louisiana, and at Catahoula Lake, Louisiana (Howard and Kantrud 1986). Identification of habitats important to wintering pintails in this region is an essential first step to maintaining winter habitat quality.

Tamisier (1974) estimated time-activity budgets of green-winged teal (Anas crecca) in France, and concluded that high diurnal use of refuge areas and nocturnal dispersal to foraging areas occurred primarily in response to avian predation, and not in response to human disturbance. Tamisier (1974) based his conclusion on the fact that diurnal concentrations and nocturnal dispersal persisted in areas with little (Turkey, Iran, and Senegal) or no (central Niger delta) hunting. Tamisier (1974) argued that decreased avian predation, increased social facilitation (including information centers), and site-

fidelity explained diurnal gregarious behavior. Similarly, Tamisier (1976:31) argued that diurnal concentration on refuge areas and nocturnal dispersal to feeding areas by green-winged teal and pintails in southwestern Louisiana were “more of a fundamental requirement of wintering dabbling ducks than an adaptation to hunting or to any other human disturbance.”

I used radio telemetry to investigate use of habitats by female pintails in southwestern Louisiana. My objectives were to: (1) quantify diel use of refuge and non-refuge areas; (2) document diel use of habitats; (3) test for variation in use of refuges and habitats in relation to female age, winter, and time period within winters; and (4) test Tamisier's (1976) hypothesis that use of refuges is unrelated to hunting. Under Tamisier's hypothesis, I predicted that relative use of refuge and non-refuge areas would not differ among hunting and non-hunting time periods.

## **STUDY AREA AND METHODS**

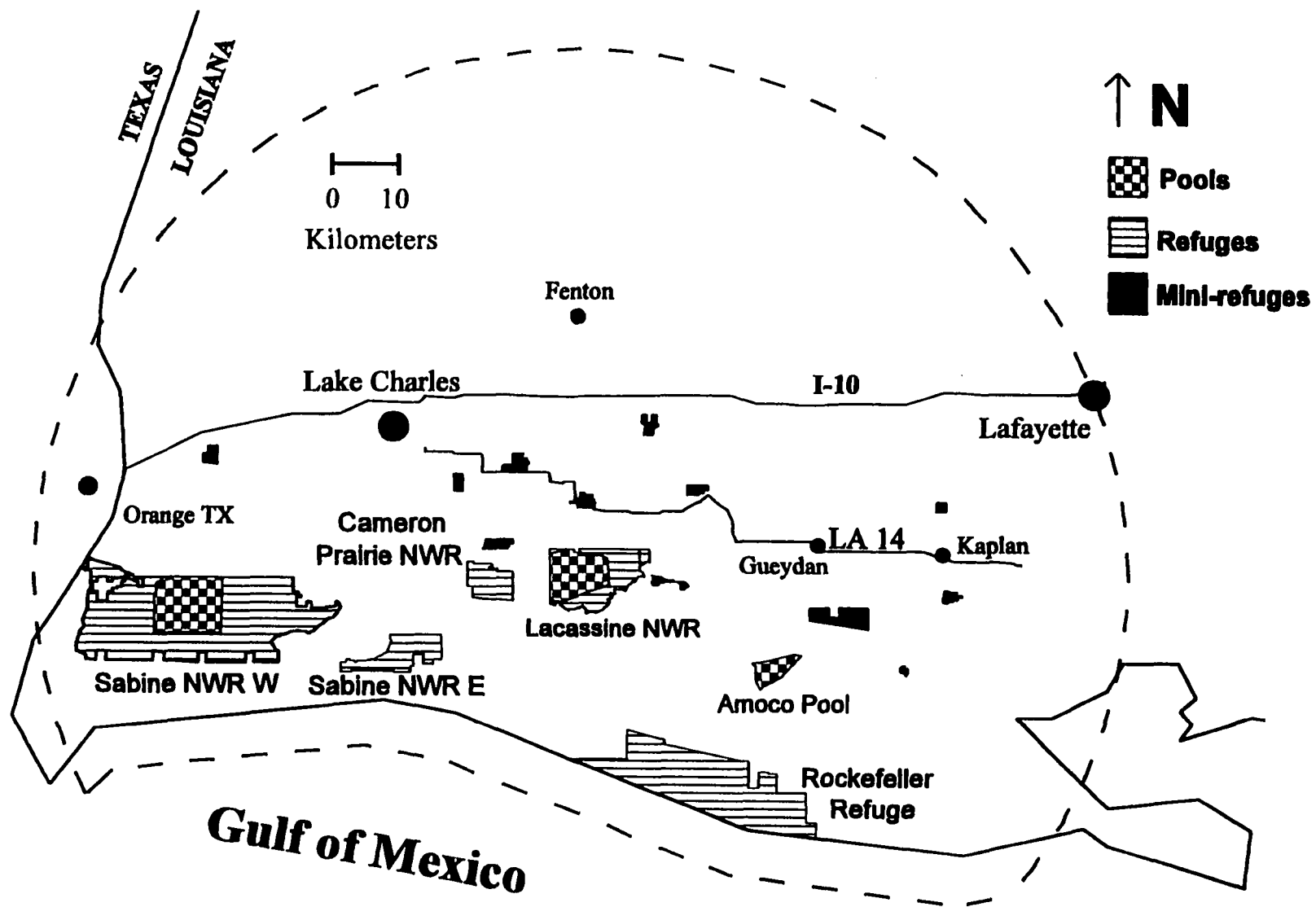
I captured female pintails from 30 September-27 October 1991 and from 4-25 October 1992 by rocket-netting over bait (Cox and Afton 1994), and fitted them with 21-g backpack-type radio transmitters (Dwyer 1972). My goal was to radio-tag equal numbers of immatures and adults, but I captured and tagged greater numbers of adults in 1991-92 ( $\underline{n}$  = 58 imm. and 97 ad.) and 1992-93 ( $\underline{n}$  = 44 imm. and 108 ad.). Numbers of females monitored each winter for habitat use were less ( $\underline{n}$  = 54 imm. and 87 ad. in 1991-92 and  $\underline{n}$  = 43 imm. and 88 ad. in 1992-93) because of mortality and emigration from the study area (R. R. Cox, unpubl. data). I captured all females on Lacassine NWR (30°01'N, 92°54'W), except for 3 trapped 8 km south of Gueydan, Louisiana (29°57'N,

92°31'W; Fig. 4.1). Cox and Afton (1994, 1996) described trap sites, aging criteria, selection of birds to instrument, and transmitter characteristics.

I monitored use of habitats by radio-tagged females within 80 km from the perimeter of Lacassine Pool (Tamisier 1976), and extending 8 km into the Gulf of Mexico (Fig. 4.1). The southern third of my study area consisted primarily of marsh, which was inaccessible by ground vehicles. Consequently, I used aircraft (Gilmer et al. 1981) to search the entire study area each day or night of tracking to avoid bias towards agricultural habitats. I did not collect habitat-use data on days when weather prohibited use of aircraft.

I divided each winter into 5 time periods based on duck hunting seasons: (1) pre-hunting season ([PRE]; 6-15 Nov 1991 and 31 Oct-20 Nov 1992); (2) first hunting season ([FHUNT]; 16 Nov-6 Dec 1991 and 21 Nov-5 Dec 1992); (3) time between split hunting seasons ([SPLIT]; 7-27 Dec 1991 and 6-25 Dec 1992); (4) second hunting season ([SHUNT]; 28 Dec 1991-5 Jan 1992 and 26 Dec 1992-9 Jan 1993); and (5) post-hunting period ([POST]; 6 Jan-19 Feb 1992 and 10 Jan-28 Feb 1993). On each day or night of tracking, I randomly selected (without replacement) a subset of 30-100 radio-tagged individuals to locate. I obtained a single location on each female included in the subset, if present in the study area. I increased the number of females selected to locate as the proportion of females located outside my study area increased, and as technicians became more expeditious. After the number of radio-tagged females in the study area had declined to approximately 50 (in Jan of each winter), I located all females present on each day or night of tracking. At the beginning of each time period, I randomly chose

Figure 4.1. Study area in which radio-tagged female northern pintails were tracked in southwestern Louisiana, 1991-92 and 1992-93.



days or nights in which to track females, and continued these types of observations until weather prohibited use of aircraft for tracking (max = 3 consecutive days or 5 consecutive nights of tracking). I systematically alternated between bouts of diurnal and nocturnal tracking among periods of favorable weather, but deviated from this pattern near the end of each time period to balance numbers of diurnal and nocturnal locations within time periods. Nonetheless, I usually obtained greater numbers of diurnal locations because fog frequently prohibited aerial tracking at night.

Each tracking day or night, I used 3 telemetry vehicles equipped with 4-element, null-peak antennas (Mech 1983) to locate birds unassisted by aircraft during the initial 2-4 hr of tracking. When aircraft located birds in accessible areas, I communicated aurally determined locations to ground vehicles for triangulation. I estimated point locations for birds triangulated from vehicles using Lenth's maximum-likelihood estimator (MLE; White and Garrott 1990), and calculated MLEs on site using laptop computers and LOCATE-II software (Nams 1990). I estimated point locations for birds located aurally in inaccessible (marsh) areas using LORAN-C. I used permanent towers to obtain most locations on Lacassine NWR and on a large pool located south of Gueydan, Louisiana, which was owned by Amoco Production Co. and maintained as a refuge (hereafter Amoco Pool [Chabreck et al. 1989]). On each area, I installed 2 11-m permanent towers, each supporting 9-element unidirectional antennas. I used Universal Transverse Mercator (UTM) system coordinates in all triangulations from vehicles and permanent towers (White and Garrott 1990), and used UTMTEL software (Dodge et al. 1986) to convert aerial locations in latitude-longitude to UTM coordinates.



I took a minimum of 3 azimuths on each located female from telemetry vehicles. I calculated 95% error ellipses (maximum likelihood procedures; Lenth 1981) of locations based on an empirically derived bearing standard deviation for my truck systems of 3.5°. When error ellipses exceeded 32.6 ha (75<sup>th</sup> percentile from 226 triangulations performed in 1990-91), I took more azimuths (usually from additional stations) until the estimated error ellipse decreased below this value.

I plotted point estimates of pintail locations on standard 7.5 min U.S. Geological Survey topographic maps and classified habitats using data from ASCS for agricultural lands and Chabreck and Linscombe (1988) for marsh areas. For analysis, I considered sanctuary and habitat attributes as potentially important factors influencing use of habitats by pintails. Accordingly, I first classified locations into 2 categories: (1) areas on which waterfowl hunting was not permitted (REFUGE), which included portions of Lacassine NWR and Sabine NWR, and all of Cameron Prairie NWR, Rockefeller State Wildlife Refuge, mini-refuges (Rave and Cordes 1993), and Amoco Pool; and (2) areas on which waterfowl hunting was permitted (NONREFUGE; Fig. 4.1).

I calculated proportional use of REFUGE and NONREFUGE areas for each bird in each time period for diurnal and nocturnal locations separately. To normalize these compositions and remove the unit sum constraint (proportions that sum to 1 are not independent [Aitchison 1986]), I constructed log-ratios by first dividing the proportional use of REFUGE by the proportional use of NONREFUGE, and then taking the naperian logarithm (Aebischer et al. 1993a). I replaced zero values with 0.007 (an order of magnitude smaller than the lowest non-zero habitat use recorded for any bird in any time

period) in order to calculate logarithms (Aebischer et al. 1993a). Choice of habitat to use as the denominator does not affect results (Aitchison 1986), and compositional data analysis is robust to choice of value used to replace zero values (Aebischer et al. 1993b). I used split-plot ANOVA (PROC GLM; SAS Institute Inc. 1989) with the log-ratio as the response variable to test for variation in use of REFUGE and NONREFUGE areas in relation to female age (immature or adult), winter (1991-92 or 1992-93), time period within winter (PRE, FHUNT, SPLIT, SHUNT, or POST), and birds. I used variation due to birds as the error term to test for effects due to age, winter, and their interaction, and residual error to test for bird and time period effects and all other interactions. I initially analyzed full models, and then used backward, stepwise procedures to eliminate non-significant ( $P > 0.05$ ) terms, beginning with the highest-order interactions (Wolfinger 1992).

To investigate use in relation to habitat, I grouped habitats based on gross similarity in vegetative characteristics, but also on amount of use by radio-tagged pintails to avoid a large number of zero values because of normality considerations (Aebischer et al. 1993a). I categorized habitats as: (1) permanent, open-water pools (POOLS), including Lacassine Pool and Amoco Pool; (2) marsh (Chabreck and Linscombe 1988) and moist-soil units (MARSH); (3) tillable lands planted in rice (RICE); (4) tillable lands left fallow, i.e., not planted to crops, including pasture (FALPAS); and (5) other agriculture, i.e., tillable lands planted in soybeans, sorghum, wheat, or ryegrass (OTHERAG). For analysis, I calculated proportional use of these 5 habitats for each bird in each time period, and constructed 4 log-ratios by dividing proportional use of

POOLS, MARSH, RICE, and OTHERAG by proportional use of FALPAS, and taking the naperian logarithm. With log-ratios as response variables, I used split-plot MANOVA (PROC GLM; SAS Institute Inc. 1989) to simultaneously test for overall differences in use of habitats in relation to age, winter, time period within winters, and birds. Model structure and error terms were the same as in my previous analysis. I again used backward, stepwise procedures to eliminate non-significant ( $P > 0.05$ ) terms, beginning with the highest-order interactions.

I was unable to gather habitat-use data at night during SHUNT in 1992-93 because inclement weather prevented aerial tracking. Therefore, I tested for variation in nocturnal use of habitats in both analyses using only PRE, FHUNT, SPLIT, and POST time periods. If winter effects and interactions were not significant ( $P > 0.05$ ), I considered observations obtained during SHUNT in 1991-92 to be representative of habitat use during this time period in both winters, and included this time period in the final fitted model. I compared relative use of REFUGE and NONREFUGE, and use of habitats relative to use of FALPAS, within levels of explanatory variables in final-fitted models by testing whether least-square means of log-ratios differed ( $P < 0.05$ ) from zero (Aebischer et al. 1993b). I compared relative use of REFUGE and NONREFUGE among levels of explanatory variables in final-fitted models using Fisher's LSD (SAS Institute Inc. 1989).

## RESULTS

### Use of REFUGE and NONREFUGE Habitats

Diurnal.--I obtained 1,816 diurnal locations on 265 females (median number of locations per female = 5; range = 1-21). My final fitted model indicated that relative use of REFUGE and NONREFUGE habitats differed among time periods ( $F = 21.41$ ; 4, 434 df,  $P < 0.0001$ ) and birds ( $F = 1.35$ ; 234, 434 df,  $P = 0.003$ ). There were no age, winter, or interaction effects (all  $P_s > 0.11$ ). Use of NONREFUGE exceeded (all  $P_s < 0.0001$ ) that of REFUGE during all non-hunting time periods (PRE, SPLIT, and POST), but use of REFUGE was greater ( $P = 0.006$ ) than that of NONREFUGE during FHUNT (Table 4.1). Use of REFUGE and NONREFUGE did not differ ( $P = 0.20$ ) during SHUNT. Use of REFUGE was greater in hunting periods (FHUNT and SHUNT) than in immediately preceding or succeeding non-hunting periods (Table 4.1). Within hunting and non-hunting time periods, use of REFUGE declined during winters. Females used REFUGE less during SHUNT than during FHUNT, and less during POST than during PRE, whereas SPLIT was intermediate (Table 4.1).

Nocturnal.--I obtained 1,495 nocturnal locations on 247 females (median number of locations per female = 4; range = 1-19). My final fitted model indicated that relative use of REFUGE and NONREFUGE differed among time periods ( $F = 2.87$ ; 3, 320 df,  $P = 0.04$ ) and birds ( $F = 1.53$ ; 245, 320 df,  $P = 0.0002$ ). There were no age, winter, or interaction effects (all  $P_s > 0.09$ ). Use of NONREFUGE was greater (all  $P_s < 0.0001$ ) than use of REFUGE during all time periods (Table 4.1). Although nocturnal use of REFUGE was low during all time periods, use decreased later in winters. Use of

Table 4.1. Diurnal and nocturnal use (percent<sup>a</sup>) of REFUGE and NONREFUGE by female northern pintails in southwestern Louisiana during winters 1991-92 and 1992-93 by time periods.

Time Period <sup>b</sup>	n <sup>c</sup>	REFUGE		NONREFUGE	
		$\bar{x}$	SE	$\bar{x}$	SE
DIURNAL					
PRE A	239	32.8	2.7	67.2	2.7
FHUNT B	195	60.2	2.9	39.8	2.9
SPLIT AC	86	28.0	4.0	72.0	4.0
SHUNT D	79	45.6	5.3	54.4	5.3
POST C	104	22.0	3.0	78.0	3.0
NOCTURNAL					
PRE A	201	13.9	2.2	86.1	2.2
FHUNT AB	163	10.0	2.0	90.0	2.0
SPLIT AB	110	10.0	2.6	90.0	2.6
SHUNT <sup>d</sup> B	55	2.7	2.0	97.3	2.0
POST B	95	3.2	1.4	96.8	1.4

<sup>a</sup>Percentages computed by calculating the percentage use of REFUGE and NONREFUGE for each female in each time period, and then averaging over females. Transformations were used in ANOVA and multiple comparisons.

<sup>b</sup>PRE = pre-hunting season; FHUNT = first hunting season, SPLIT = time between split hunting seasons; SHUNT = second hunting season; POST = post-hunting season. Time periods followed by the same letter do not differ (Fisher's LSD;  $P > 0.05$ ) in relative use of REFUGE and NONREFUGE within diurnal and nocturnal groups.

<sup>c</sup>Sample size represents number of radio-tagged females monitored.

<sup>d</sup>Data collected in 1991-92 only (see Methods).

REFUGE was greater during PRE than during SHUNT and POST, whereas use during FHUNT and SPLIT was intermediate (Table 4.1).

#### Use of Habitats

Diurnal.--My final fitted model indicated that time-period differences in use of habitats were not consistent between winters (winter-by-time period interaction; MANOVA; Wilks' lambda = 0.838;  $F = 4.87$ ; 16, 1305.1 df;  $P < 0.0001$ ), and that individual females were consistent in their use of habitats among time periods (bird effect; MANOVA; Wilks' lambda = 0.101;  $F = 1.26$ ; 1052, 1710.8 df;  $P < 0.0001$ ). There were no age or other interaction effects (all  $P_s > 0.06$ ). In 1991-92, females used FALPAS more (all  $P_s < 0.05$ ) than POOLS during non-hunting seasons (PRE, SPLIT, and POST), but use of POOLS exceeded ( $P < 0.0001$ ) or did not differ ( $P = 0.21$ ) from use of FALPAS during FHUNT and SHUNT, respectively (Table 4.2). In 1992-93, relative use of FALPAS and POOLS differed ( $P_s < 0.003$ ) only during FHUNT and SHUNT. In 1991-92, use of FALPAS was greater (all  $P_s < 0.05$ ) than that of RICE during all time periods except FHUNT, when use did not differ ( $P = 0.67$ ). However, relative use of FALPAS and RICE did not differ (all  $P_s > 0.05$ ) in 1992-93 during any time period except SHUNT, when use of FALPAS was greater ( $P = 0.006$ ). In both winters, females used FALPAS more (all  $P_s < 0.05$ ) than OTHERAG (primarily soybeans) during all time periods except SPLIT in 1992-93, when use did not differ ( $P = 0.22$ ).

Nocturnal.--My final fitted model indicated that time-period differences in nocturnal use of habitats were not consistent between winters (winter-by-time period

Table 4.2. Diurnal use (percent<sup>a</sup>) of habitats (POOLS = pools, MARSH = marsh, FALPAS = fallow and pasture, RICE = rice, and OTHERAG = other agriculture) by female northern pintails in southwestern Louisiana during each winter and time period.

Winter	Time Period <sup>b</sup>	n <sup>c</sup>	POOLS		MARSH		FALPAS		RICE		OTHERAG	
			$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
1991-92	PRE	113	15.9	3.5	24.8	4.1	38.1	4.6	21.2	3.9	0.0	0.0
	FHUNT	94	50.5	4.4	30.9	4.2	13.8	3.0	4.8	1.5	0.0	0.0
	SPLIT	55	23.0	3.8	25.2	4.6	43.9	4.7	4.5	1.9	3.3	1.7
	SHUNT	58	41.4	6.0	24.1	5.1	25.0	5.3	7.8	3.2	1.7	1.7
	POST	57	16.6	4.2	18.2	4.5	52.3	5.2	10.2	2.2	2.8	1.4
1992-93	PRE	126	24.2	3.1	35.4	3.4	14.7	2.3	19.7	2.6	6.0	1.7
	FHUNT	101	37.5	3.6	22.3	3.3	15.7	2.6	20.3	3.3	4.3	1.5
	SPLIT	31	19.4	7.2	6.5	4.5	32.3	8.5	29.0	8.3	12.9	6.1
	SHUNT	21	4.8	4.8	9.5	6.6	57.1	11.1	14.3	7.8	14.3	7.8
	POST	47	17.0	3.2	8.3	2.0	25.2	2.6	29.7	3.5	19.8	3.3

<sup>a</sup>Percentages computed by calculating the percentage use of each habitat for each female in each time period, and then averaging over females. Transformations were used in MANOVA analysis.

<sup>b</sup>PRE = pre-hunting season; FHUNT = first hunting season, SPLIT = time between split hunting seasons; SHUNT = second hunting season; POST = post-hunting season.

<sup>c</sup>Sample size represents number of radio-tagged females monitored.

interaction; MANOVA; Wilks' lambda = 0.883;  $F = 3.33$ ; 12, 831.1 df;  $P < 0.0001$ ).

There were no age, bird, or other interaction effects (all  $P_s > 0.08$ ). Nocturnal use of FALPAS and RICE combined ranged from 67.6 to 92.7% during all winters and time periods, and most ( $\bar{x}$  of percentages calculated within time-period and winter combinations = 95.3%; range = 88.8-100%) of this use was on NONREFUGE lands.

Use of FALPAS and RICE on privately owned lands that were hunted during the day accounted for 60.0-90.9% of nocturnal use of habitats. Nocturnal use of FALPAS was greater (all  $P_s < 0.02$ ) than that of POOLS, MARSH, or OTHERAG during all time period-winter combinations, except that use of FALPAS and MARSH did not differ ( $P = 0.07$ ) during PRE in 1992-93 (Table 4.3). In 1991-92, use of FALPAS was greater (all  $P_s < 0.03$ ) than that of RICE during FHUNT, SPLIT, and POST, but use of these habitats did not differ ( $P = 0.31$ ) during PRE (Table 4.3). In contrast, use of RICE exceeded (all  $P_s < 0.005$ ) that of FALPAS in 1992-93 during PRE, FHUNT, and SPLIT, but use of these habitats did not differ ( $P = 0.30$ ) during POST (Table 4.3).

## DISCUSSION

I found that pintails in southwestern Louisiana shifted daytime use from NONREFUGE to REFUGE areas during hunting seasons, probably in response to hunting pressure. Pintails in Mexico also apparently shifted daytime use from hunted marsh areas to non-hunted agricultural fields and reservoirs in response to hunting pressure (Migoya et al. 1994). Consequently, I reject Tamisier's (1976) hypothesis that diurnal use of refuges by pintails is not influenced by hunting. Moreover, I argue that alternative benefits of diurnal concentrations (i.e., decreased avian predation, increased



Table 4.3. Nocturnal use (percent<sup>a</sup>) of habitats (POOLS = pools, MARSH = marsh, FALPAS = fallow and pasture, RICE = rice, and OTHERAG = other agriculture) by female northern pintails in southwestern Louisiana for each winter and time period.

Winter	Time Period <sup>b</sup>	n <sup>c</sup>	POOLS		MARSH		FALPAS		RICE		OTHERAG	
			$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
1991-92	PRE	76	5.3	2.6	3.9	2.2	43.4	5.7	47.4	5.8	0.0	0.0
	FHUNT	68	0.5	0.5	16.4	3.8	58.7	5.2	23.2	4.3	1.2	0.9
	SPLIT	28	3.6	3.6	14.3	6.7	67.9	9.0	14.3	6.7	0.0	0.0
	SHUNT <sup>d</sup>	55	0.0	0.0	4.5	2.7	80.0	5.1	12.7	4.1	2.7	2.0
	POST	55	0.6	0.6	4.7	1.7	63.1	4.5	28.9	4.2	2.7	1.3
1992-93	PRE	125	4.8	1.7	18.4	3.0	25.6	3.4	42.0	3.8	9.2	2.4
	FHUNT	95	5.8	2.1	13.7	3.2	25.8	4.0	48.9	4.4	5.8	2.1
	SPLIT	82	3.0	1.8	7.9	2.7	27.4	4.0	51.2	4.5	10.4	2.8
	SHUNT <sup>e</sup>											
	POST	40	0.6	0.5	4.8	2.4	29.2	3.8	47.4	4.6	18.0	3.8

<sup>a</sup>Percentages computed by calculating the percentage use of each habitat for each female in each time period, and then averaging over females. Transformations were used in MANOVA analysis.

<sup>b</sup>PRE = pre-hunting season; FHUNT = first hunting season, SPLIT = time between split hunting seasons; SHUNT = second hunting season; POST = post-hunting season.

(table con'd)

<sup>c</sup>Sample size represents number of radio-tagged females monitored.

<sup>d</sup>Data not included in statistical tests (see Methods).

<sup>e</sup>Data not collected (see Methods).

social facilitation, and site-fidelity; Tamisier [1974], Rave and Cordes [1993]) do not explain my finding of increased diurnal use of REFUGE during hunting seasons. These alternative benefits should not differ between refuge and non-refuge areas coincidentally with duck hunting seasons. Mean use of REFUGE was greater during the day than at night during all time periods, but more so during hunting seasons. Greater diurnal than nocturnal use of refuges during non-hunting seasons may be related to other forms of disturbance (e.g., agricultural operations, goose hunting, etc.), which are greater during the day. I conclude that hunting and probably other diurnal forms of disturbance are major factors affecting use of habitats by female pintails in southwestern Louisiana.

Nocturnal use of refuges was low, and decreased as winter progressed. Within hunting and non-hunting time periods, diurnal use of refuges also decreased later in winters. Cox and Afton (1996) previously reported that evening flights of females from Lacassine NWR increased in distance and duration during winters. Although alternative hypotheses could explain these findings, all of these results are consistent with refuging theory (Hamilton and Watt 1970), suggesting that food resources on and near refuges may be depleted during winters.

I believe that differences in diurnal use of habitats between winters and among time periods were influenced primarily by large annual differences in relative abundances of agricultural habitats. Wet conditions during spring and summer of 1991 (Muller 1991) produced poor planting conditions for soybeans. Consequently, fallow land was more abundant and soybeans were less abundant among the 3 primary agricultural parishes in southwestern Louisiana in 1991-92 than in 1992-93 (Table 4.4). Also, more land was

Table 4.4. Summary of rice, fallow, and soybean agriculture (ha) by parish and winter in southwestern Louisiana.

Parish	Rice <sup>a</sup>			Fallow <sup>b</sup>			Soybeans <sup>a</sup>		
	1991-92	1992-93	% Change	1991-92	1992-93	% Change	1991-92	1992-93	% Change
Jefferson Davis	36,219	39,254	+8.4	65,964	17,401	-73.6	5,099	18,616	+265.1
Acadia	36,624	38,850	+6.1	56,927	20,558	-63.9	3,237	28,733	+788.9
Vermilion	37,231	41,278	+10.9	54,491	35,677	-34.5	6,839	19,830	+190.0
Combined	110,074	119,382	+8.5	177,382	73,636	-58.5	15,175	67,179	+342.7

<sup>a</sup>Zapata and Frank (1993).

<sup>b</sup>Data provided by ASCS and SCS offices in each parish.

planted in rice in these parishes in 1992-93 than in 1991-92. In 1991-92, when fallow land was more abundant than rice or soybeans, females used FALPAS more than RICE during the day in 4 of 5 time periods, and used FALPAS more than OTHERAG in all time periods. In 1992-93, when rice was more abundant than fallow land or soybeans, daytime use of FALPAS and RICE did not differ in 4 of 5 time periods, but pintail use of FALPAS continued to be greater than that of OTHERAG in 4 of 5 time periods. These findings suggest that among agricultural habitats, females preferentially sought FALPAS over RICE. Low use of OTHERAG may reflect high rates of seed deterioration of submerged soybeans (86% after 90 days) relative to domestic rice (19% after 90 days) and moist-soil seeds (generally <10% after 90 days; Neely 1956), the latter of which are common in both rice (Hohman et al. 1996) and fallow fields. I also believe that differences in diurnal use of habitats between winters and among time periods were influenced by sanctuary attributes. For example, females used POOLS, which were found only on REFUGE habitats, more than FALPAS only during FHUNT of both winters.

I did not consider relative availabilities of habitats in my analyses. In resource selection studies where individual animals are identified, resource availability is measured either within the home range of each individual or from an arbitrarily defined study area (Thomas and Taylor 1990). Home-range estimation for pintails in my study area was not possible because of the small number of locations per individual, particularly within time periods. Within my study area, timing of agricultural harvest and ephemeral changes in flooding conditions in agricultural fields in response to frequent and often sizable rainfalls

probably influenced attractiveness of habitats, and consequently should be incorporated into availability considerations. Because of difficulties in measuring “availability”, I limited my interpretations of habitat preference to large differences in use relative to amounts of agricultural habitats within my study area between winters.

Because pintails in southwestern Louisiana apparently forage primarily at night (Tamisier 1976, Yakupzack 1988), information on nocturnal use of habitats may be particularly useful in understanding how pintails meet energetic needs during winter. At night, females consistently used FALPAS more than POOLS, MARSH, and OTHERAG. However, relative use of FALPAS and RICE appeared to be influenced primarily by abundance of these habitats. In 1991-92, when fallow lands were more abundant than rice, females used FALPAS more than RICE at night in 3 of 4 time periods. In contrast, when rice was more abundant than fallow lands in 1992-93, females used RICE more than FALPAS at night in 3 of 4 time periods. The vast majority of nocturnal use of rice and fallow agriculture occurred on privately owned, non-refuge lands. In conclusion, my results indicate that: (1) female pintails wintering in southwestern Louisiana rely primarily on refuges to escape hunting pressure, (2) female pintails appear to obtain much (possibly most) of their dietary needs by foraging at night in privately owned rice and fallow agricultural lands that are hunted during the day, and (3) relative reliance by female pintails on rice and fallow agriculture is influenced by gross changes in abundance of these habitats.

## RESEARCH AND MANAGEMENT IMPLICATIONS

I recommend that investigators consider time of day and time of wintering period in relation to hunting as potential sources of variation in future studies of habitat use by wintering waterfowl. Investigations of habitat use restricted to diurnal hours may overestimate use of habitats common on refuge areas (and consequently underestimate use of foraging habitats), more so in areas where feeding is primarily nocturnal. Numbers of waterfowl counted during surveys of daytime concentration areas may vary depending on whether or not hunting is occurring. I recommend that these types of surveys be standardized with respect to hunting seasons to decrease variance of estimates for examining trends.

Diurnally, females used refuges extensively during hunting periods, whereas agricultural habitats on non-refuge areas comprised the majority of nocturnal use of habitats throughout winters. Pintails (Miller 1985, 1987, Miller et al. 1995) and other waterfowl, e.g., snow geese (Anser caerulescens; Frederick et al. 1987), elsewhere similarly roost on refuges and feed in adjacent agricultural land during winter. Therefore, I recommend that proximity of refuge areas to agricultural habitats, and planting of agricultural crops on refuges, should be considered in management plans for wintering pintails and other waterfowl. Food availability on refuges and juxtaposition of feeding areas and refuges may be important in determining daily energy expenditure of wintering waterfowl, particularly during hunting seasons (Frederick et al. 1987).

I believe that further investigation into several areas of wintering ecology of pintails in southwestern Louisiana is needed. Specifically, information on temporal

variation in nutrient-reserve dynamics, foraging ecology (including foraging efficiency), and nocturnal time budgets would greatly enhance our understanding of how pintails respond to conditions specific to various portions of the wintering period. Variation in habitat features and corresponding attractiveness values in relation to rainfall also should be considered in subsequent investigations.

### LITERATURE CITED

- Aebischer, N. J., P. A. Robertson, and R. E. Kenward. 1993a. Compositional analysis of habitat use from animal radio-tracking data. *Ecology* 74:1313-1325.
- , V. Marcstrom, R. E. Kenward, and M. Karlbom. 1993b. Survival and habitat utilisation: a case for compositional analysis. Pages 343-353 in J. D. Lebreton and P. M. North, eds. *Marked individuals in the study of bird population*. Birkhauser Verlag Basel, Switz.
- Aitchison, J. 1986. *The statistical analysis of compositional data*. Chapman and Hall, London, U. K. 416pp.
- Chabreck, R. H., and G. Linscombe. 1988. Vegetative type map of the Louisiana coastal marshes. Louisiana Dep. of Wildl. and Fisheries, New Orleans. 1p.
- , T. Joanen, and S. L. Paulus. 1989. Southern coastal marshes and lakes. Pages 249-277 in L. M. Smith, R. L. Pederson, and R. M. Kaminski, eds. *Habitat management for migrating and wintering waterfowl in North America*. Texas Tech Univ. Press, Lubbock.
- Cox, R. R., Jr., and A. D. Afton. 1994. Portable platforms for setting rocket nets in open-water habitats. *J. Field Ornithol.* 65:551-555.
- , and -----. 1996. Evening flights of female northern pintails from a major roost site. *Condor*: In Press.
- Dodge, W. E., D. S. Wilkie, and A. J. Steiner. 1986. UTMTEL: a laptop computer program for location of telemetry "finds" using LORAN C. Massachusetts Coop. Wildl. Res. Unit, Amherst. 21pp.
- Ducks Unlimited, Inc. 1990. Sprig: population recovery strategy for the northern pintail. Ducks Unlimited, Inc., Long Grove, Ill. 30pp.



- Dwyer, T. J. 1972. An adjustable radio-package for ducks. *Bird-Banding* 43:282-284.
- Frederick, R. B., W. R. Clark, and E. E. Klaas. 1987. Behavior, energetics, and management of refuging waterfowl: a simulation model. *Wildl. Monogr.* 96. 35pp.
- Gilmer, D. S., L. M. Cowardin, R. L. Duval, L. M. Mechlin, C. W. Shaiffer, and V. B. Kuechle. 1981. Procedures for the use of aircraft in wildlife biotelemetry studies. U. S. Fish and Wildl. Serv. Resour. Publ. 140. 19pp.
- Hamilton, W. J., III, and K. E. F. Watt. 1970. Refuging. *Annu. Rev. Ecol. Syst.* 1:263-286.
- Hohman, W. L., T. M. Stark, and J. L. Moore. 1996. Food availability and feeding preferences of breeding fulvous whistling-ducks in Louisiana ricefields. *Wilson Bull.* 108:137-150.
- Howard, R. J., and H. A. Kantrud. 1986. Habitat suitability models: northern pintail (Gulf Coast wintering). *Natl. Wetlands Res. Center, U.S. Fish and Wildl. Serv. Biol. Rep.* 82(10.121). 16pp.
- Lenth, R. V. 1981. On finding the source of a signal. *Technometrics* 23:149-154.
- Mech, L. D. 1983. *Handbook of animal radio-tracking*. University of Minnesota Press, Minneapolis. 107pp.
- Migoya, R., G. A. Baldassarre, and M. P. Losito. 1994. Diurnal activity budgets and habitat functions of Northern Pintail Anas acuta wintering in Sinaloa, Mexico. *Wildfowl* 45:134-146.
- Miller, M. R. 1985. Time budgets of northern pintails wintering in the Sacramento Valley, California. *Wildfowl* 36:53-64.
- , 1987. Fall and winter foods of northern pintails in the Sacramento Valley, California. *J. Wildl. Manage.* 51:405-414.
- , J. P. Fleskes, D. L. Orthmeyer, W. E. Newton, and D. S. Gilmer. 1995. Survival of adult female northern pintails in Sacramento Valley, California. *J. Wildl. Manage.* 59:478-486.
- Muller, R. A. 1991. Louisiana monthly climate review: August. Louisiana Office of State Climatology, Louisiana State Univ., Baton Rouge. 8pp.

- Nams, V. O. 1990. Locate II: User's guide. Pacer. Truro, Nova Scotia, Canada. 84pp.
- Neely, W. W. 1956. How long do duck foods last underwater? Trans. N. Am. Wildl. Conf. 21:191-198.
- Rave, D. P., and C. L. Cordes. 1993. Time-activity budget of northern pintails using nonhunted rice fields in southwest Louisiana. J. Field Ornithol. 64:211-218.
- Raveling, D. G., and M. E. Heitmeyer. 1989. Relationships of population size and recruitment of pintails to habitat conditions and harvest. J. Wildl. Manage. 53:1088-1103.
- SAS Institute Inc. 1989. SAS/STAT User's Guide, Version 6, Fourth ed., Vol. 2. SAS Institute Inc. Cary, N.C. 846pp.
- Tamisier, A. 1974. Etho-ecological studies of teal wintering in the Camargue (Rhône Delta, France). Wildfowl 25:123-133.
- 1976. Diurnal activities of green-winged teal and pintail wintering in Louisiana. Wildfowl 27:19-32.
- Thomas, D. L., and E. J. Taylor. 1990. Study designs and tests for comparing resource use and availability. J. Wildl. Manage. 54:322-330.
- U. S. Fish and Wildlife Service and Canadian Wildlife Service. 1986. North American waterfowl management plan. Washington, D.C. 31pp.
- U. S. Fish and Wildlife Service and Canadian Wildlife Service. 1995. Waterfowl population status, 1995. Off. Migr. Bird Manage., Laurel, Md. 45pp.
- White, G. C., and R. A. Garrott. 1990. Analysis of wildlife radio-tracking data. Academic Press, San Diego, Calif. 383pp.
- Wolfinger, R. 1992. A tutorial on mixed models. SAS Institute Inc., Cary, N.C. 38pp.
- Yakupzack, P. 1988. Wildlife disease contingency plan. Lacassine Natl. Wildl. Ref., Lake Arthur, La. 23pp.
- Zapata, H. O., and D. Frank. 1993. Agricultural statistics and prices for Louisiana, 1986-1992. Louisiana Agric. Stat. Serv., Dep. of Agric. Econ. and Agribusiness Infor. Ser. No. 116. 73pp.

## **Chapter 5**

### **Use of Mini-refuges by Female Northern Pintails Wintering in Southwestern Louisiana**

#### **INTRODUCTION**

The Gulf Coasts of Texas and southwestern Louisiana host some of the largest concentrations of northern pintails (Anas acuta; hereafter pintails) wintering in the Central and Mississippi Flyways (Howard and Kantrud 1986). Large numbers of pintails concentrate diurnally on Lacassine National Wildlife Refuge (NWR) in southwestern Louisiana, with peak numbers averaging over 95,000 from winters 1980-81 to 1993-94 (Lacassine NWR, unpubl. data). Pintails use Lacassine NWR, particularly a 6793-ha impoundment known as Lacassine Pool, primarily as a daytime roost, dispersing at night to feed in agricultural areas (Tamisier 1976, Yakupzack 1988, Cox and Afton 1996, Chapter 4).

In 1988, the Gulf Coast Joint Venture of the North American Waterfowl Management Plan (U.S. Fish and Wildlife Service [USFWS] and Canadian Wildlife Service 1986) began leasing (at no cost) private agricultural fields (hereafter mini-refuges) in southwestern Louisiana to provide additional sanctuary for pintails (R. Helm, LA Dep. Wildl. and Fisheries, Baton Rouge, LA and R. Aycock, USFWS, Jackson, MS, pers. comms.). Rave and Cordes (1993) used time-activity budgets to determine whether pintails would use mini-refuges. They reported that pintails concentrated on mini-refuges only during the day, and suggested that mini-refuges may be more attractive

to pintails than permanent open-water pools because mini-refuges provide the security of open-water and food.

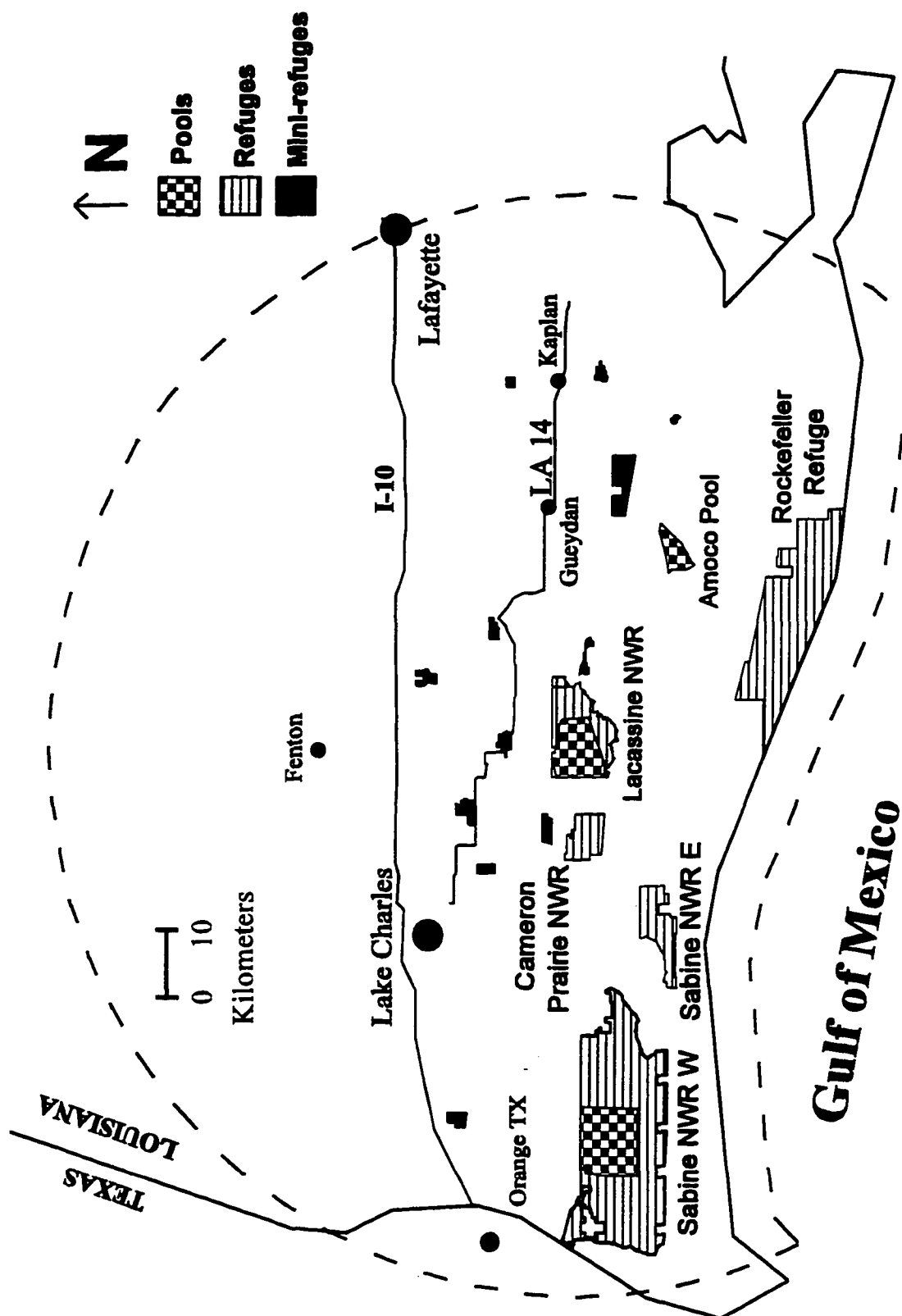
In this paper, I assess the relative importance of mini-refuges and pools to pintails in southwestern Louisiana. My specific objectives were to: (1) quantify diel use of mini-refuges and pools, and (2) examine variation in use of these areas in relation to female age, time period, and winter.

## **STUDY AREA AND METHODS**

My study area included all lands within 80 km of the perimeter of Lacassine Pool and extended 8 km into the Gulf of Mexico (Fig. 5.1). This area included 12 mini-refuges, ranging in size from 137 to 2514 ha (Fig. 5.1). Five mini-refuges established in winter 1988-89 were the same as those studied by Rave and Cordes (1993). Four mini-refuges were added in 1989-90, and 3 other areas were added in 1991-92. Detailed descriptions of mini-refuges are given elsewhere (Rave 1989, Parker 1990, Lacassine NWR 1992, Rave and Cordes 1993).

I captured female pintails from 28 Sep. to 27 Oct. 1991 and from 4 to 25 Oct. 1992 by rocket-netting over bait using portable platforms (Cox and Afton 1994). All pintails were captured on Lacassine NWR (30°01'N, 92°54'W), except for 3 trapped 8 km south of Gueydan, Louisiana (29°57'N, 92°31'W; Fig. 5.1). Following capture, I tagged females with 21-g backpack-type radio transmitters (Dwyer 1972). I previously described trap sites, aging criteria, selection of birds to instrument, and transmitter characteristics (Cox and Afton 1994, 1996).

Figure 5.1. Study area in which radio-tagged female northern pintails were tracked in southwestern Louisiana during winters 1991-92 and 1992-93.



From 6 Nov. 1991 to 19 Feb. 1992 and from 31 Oct. 1992 to 28 Feb. 1993, I attempted to locate radio-tagged females once each day (either diurnal or nocturnal) in my study area. I used aircraft (Gilmer et al. 1981) to search the entire study area each day or night of tracking to avoid underestimating use of marsh areas, which generally were inaccessible by telemetry vehicles. I previously described tracking methodology, including daily selection of birds to locate, antenna systems, and point estimation and accuracy (Chapter 4).

I divided winters into 5 time periods based on duck hunting seasons: (1) pre-hunting season ([PRE]; 6-15 Nov. 1991 and 31 Oct.-20 Nov. 1992), 2) first hunting season ([FHUNT]; 16 Nov.-6 Dec. 1991 and 21 Nov.-5 Dec. 1992), 3) time between split hunting seasons ([SPLIT]; 7-27 Dec. 1991 and 6-25 Dec. 1992), 4) second hunting season ([SHUNT]; 28 Dec. 1991-5 Jan. 1992 and 26 Dec. 1992-9 Jan. 1993), and 5) post-hunting season ([POST]; 6 Jan.-19 Feb. 1992 and 10 Jan.-28 Feb. 1993). I attempted to obtain equal numbers of daytime and nighttime locations within time periods, but usually obtained more daytime locations because fog often prohibited aerial tracking at night.

For analysis, I first classified pintail locations into 4 habitat categories: (1) mini-refuges (MINIREF); (2) Lacassine Pool (LACPOOL); (3) Amoco Pool (AMPOOL; Chabreck et al. 1989), formerly known as Pan American Pool (Tamisier 1976); and (4) all other areas (OTHER). I subsequently calculated proportional use of these habitats for each bird in each time period, (i.e., compositions), separately for diurnal and nocturnal locations. To normalize compositions and remove the unit sum constraint

(proportions that sum to 1 are not independent [Aitchison 1986]), I constructed 3 log-ratios by first dividing the proportional use of LACPOOL, AMPOOL, and OTHER by the proportional use of MINIREF, and then taking the natural logarithm (Aebischer et al. 1993a). I replaced 0 values with 0.007 (an order of magnitude smaller than the lowest non-zero value for any bird in any time period) in order to calculate logarithms (Aebischer et al. 1993a). Choice of which habitat to use as the denominator does not affect results (Aitchison 1986), and compositional data analysis is robust to choice of value used to replace zero values (Aebischer et al. 1993b). I used MANOVA (PROC GLM; SAS Institute 1989) with log-ratios as response variables to simultaneously test for differences in relative use of these habitats in relation to female age (immature or adult), time period (PRE, FHUNT, SPLIT, SHUNT, or POST), and winter (1991-92 or 1992-93). I used variation among individual birds as the error term to test effects due to age, winter, and their interaction, and residual error to test bird and time period effects and all other interactions. I initially analyzed full models, and then used backward, stepwise procedures to eliminate non-significant ( $P > 0.05$ ) terms, beginning with the highest-order interactions (Wolfinger 1992). I made pairwise tests of relative use of habitats by testing whether least-square means of log-ratios differed ( $P < 0.05$ ) from 0 within levels of explanatory variables in final-fitted models (Aebischer et al. 1993b).

I was unable to collect data at night during SHUNT in 1992-93 because inclement weather prevented aerial tracking. Therefore, I tested for differences in nocturnal habitat use using only PRE, FHUNT, SPLIT, and POST time periods.



## RESULTS

### Diurnal

I obtained 1816 diurnal locations on 265 females (Fig. 5.2). My final fitted MANOVA model indicated that use of MINIREF, LACPOOL, AMPOOL, and OTHER differed among time periods, but differences were not consistent among winters (winter-by-time period interaction; Wilks' lambda = 0.85;  $F = 5.88$ ; 12, 1132.7 df;  $P < 0.0001$ ), and that individual females were consistent in their use of these areas among time periods (bird effect; Wilks' lambda = 0.18;  $F = 1.23$ ; 789, 1284.9 df;  $P = 0.0005$ ). Age effects and remaining interactions were not significant ( $P_s > 0.48$ ). Females used LACPOOL more ( $P_s < 0.02$ ) than MINIREF during 8 of 10 time period and winter comparisons (Table 5.1). Females used MINIREF more ( $P = 0.007$ ) than LACPOOL during SHUNT in 1992-93, whereas use of these areas did not differ ( $P = 0.85$ ) during SPLIT in 1992-93. Relative use of MINIREF and AMPOOL did not differ ( $P_s > 0.12$ ) among time periods and between winters except during FHUNT in 1992-93, when use of AMPOOL was greater ( $P < 0.0001$ ; Table 5.1). Females used LACPOOL more ( $P_s < 0.05$ ) than AMPOOL during all time periods and winters except SPLIT and SHUNT in 1992-93, when use of these pools did not differ ( $P_s = 0.80$  and  $0.08$ , respectively).

### Nocturnal

I obtained 1495 nocturnal locations on 247 females (Fig. 5.3). Relative nocturnal use of MINIREF, LACPOOL, AMPOOL, and OTHER did not differ in relation to age, winter, time period, or bird (all  $P_s > 0.05$ ). Overall nocturnal use of AMPOOL ( $\bar{x} \pm SE = 0.6 \pm 0.3\%$ ) was less than that of LACPOOL ( $\bar{x} \pm SE = 2.2 \pm 0.7\%$ ;  $P = 0.009$ ) and

Figure 5.2. Diurnal locations ( $n = 1816$ ) of 265 radio-tagged female northern pintails during winters 1991-92 and 1992-93. Number of locations per habitat type are: LACPOOL = 374, AMPOOL = 64, MINIREF = 32, OTHER = 1314. Dashed lines show study area boundary.

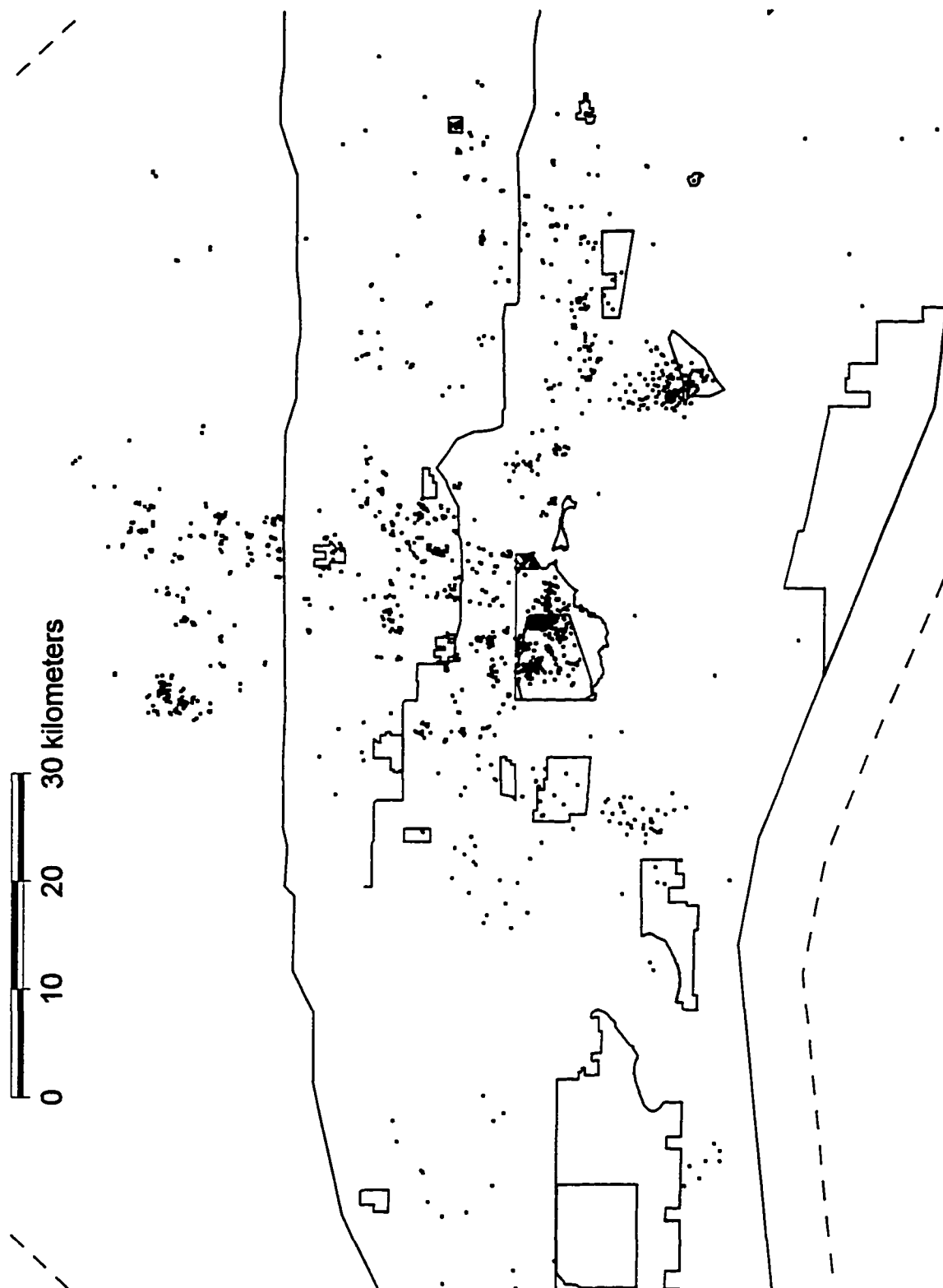


Table 5.1. Diurnal use (percent<sup>a</sup>) of Lacassine Pool (LACPOOL), Amoco Pool (AMPOOL), mini-refuges (MINIREF), and other areas (OTHER) by radio-tagged female northern pintails in southwestern Louisiana for each time period and winter.

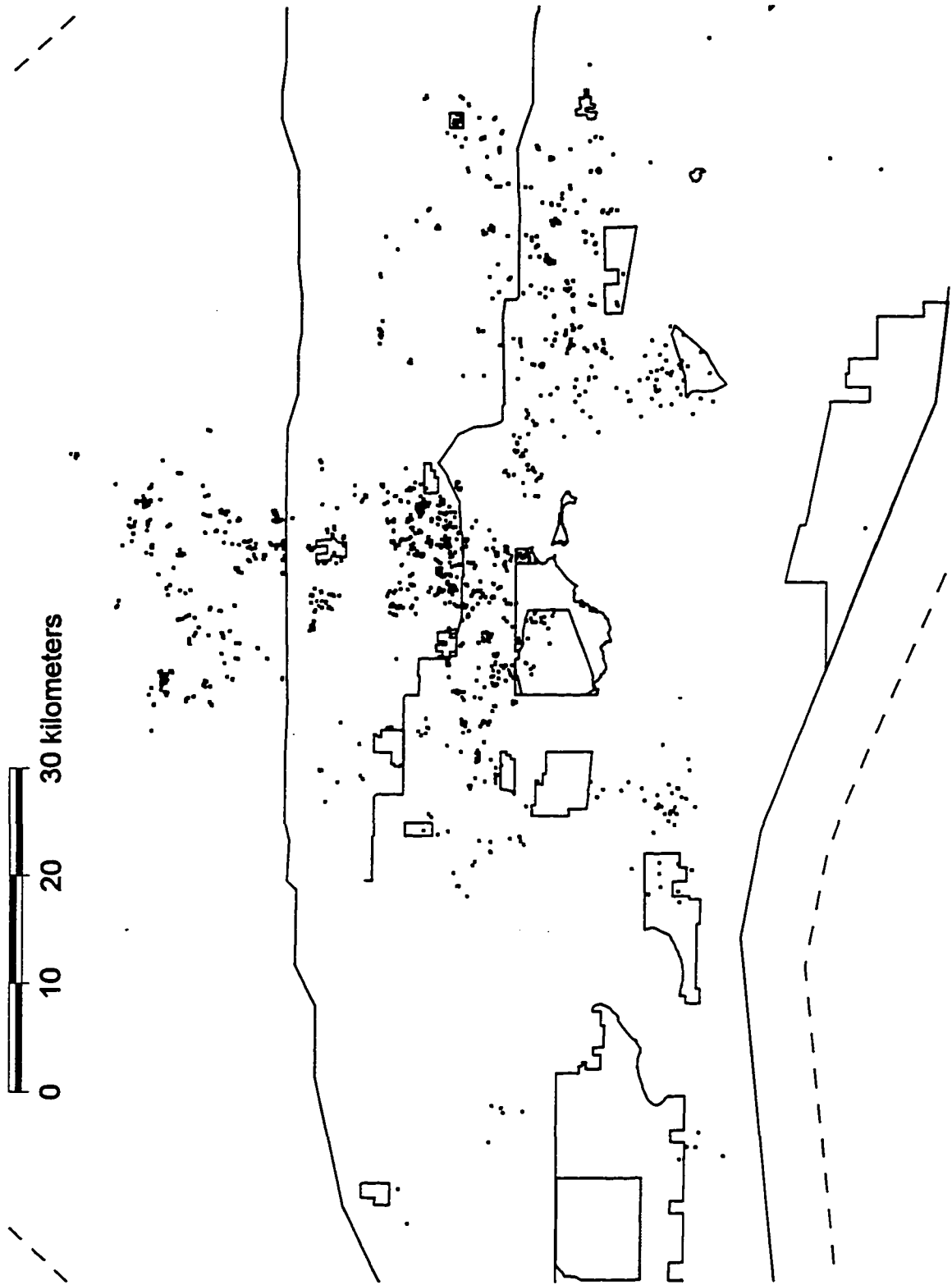
Winter	Time Period <sup>b</sup>	n <sup>c</sup>	LACPOOL		AMPOOL		MINIREF		OTHER	
			$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
1991-92	PRE	113	15.9	3.5	0.0	0.0	0.0	0.0	84.1	3.5
1992-93		126	21.8	3.1	2.4	1.1	0.8	0.6	75.0	3.2
1991-92	FHUNT	94	50.2	4.4	0.4	0.4	0.0	0.0	49.5	4.4
1992-93		101	24.8	3.4	12.7	2.7	4.1	1.4	58.4	3.8
1991-92	SPLIT	55	22.6	3.8	0.5	0.5	0.0	0.0	77.0	3.8
1992-93		31	9.7	5.4	9.7	5.4	6.5	4.5	74.2	8.0
1991-92	SHUNT	58	38.8	5.9	2.6	1.9	1.7	1.7	56.9	6.1
1992-93		21	0.0	0.0	4.8	4.8	19.0	8.8	76.2	9.5
1991-92	POST	57	16.6	4.2	0.0	0.0	0.2	0.2	83.2	4.1
1992-93		47	12.3	3.0	4.7	1.8	1.6	0.7	81.4	3.2

<sup>a</sup>Percentages computed by calculating the percentage use of each habitat for each female in each time period, and then averaging over females. Transformations were used in MANOVA analysis.

<sup>b</sup>PRE = pre-hunting season; FHUNT = first hunting season, SPLIT = time between split hunting seasons; SHUNT = second hunting season; POST = post-hunting season.

<sup>c</sup>Sample size represents number of radio-tagged females monitored.

Figure 5.3. Nocturnal locations ( $n = 1495$ ) of 247 radio-tagged female northern pintails during winters 1991-92 and 1992-93. Number of locations per habitat type are: LACPOOL = 25, AMPOOL = 6, MINIREF = 28, OTHER = 1436. Dashed lines show study area boundary.



that of MINIREF ( $\bar{x} \pm SE = 2.6 \pm 0.8\%$ ;  $P = 0.004$ ), whereas use of LACPOOL and MINIREF did not differ ( $P = 0.78$ ).

## DISCUSSION

Most (99%) of my radio-tagged females were captured on Lacassine NWR; thus, trapping location could have influenced subsequent use of specific refuges, at least initially. Trapping sites on Lacassine NWR were prepared by flooding and rolling vegetation in moist-soil units, attracting large numbers of pintails (max = 7,000) in October each winter. I did not observe pintails using mini-refuges during October of either winter, nor did I observe concentrations of >500 pintails in other portions of the study area. Of the 3 females trapped near Gueydan, Louisiana, 1 was located 13 times, but never on mini-refuges or pools. Locations of the other 2 individuals were determined 7 and 21 times, of which 1 and 5, respectively, were on LACPOOL. These individuals were never located on mini-refuges or AMPOOL. Further, I recorded dense concentrations of pintails in portions of the study area that were relatively far from my primary trap site on Lacassine NWR, (e.g., on and immediately north of AMPOOL; Figs. 5.1-5.3). Thus, I believe that trapping location bias did not seriously affect my results, if at all, because: (1) I trapped pintails from the largest concentrations in southwestern Louisiana, (2) data from radio-tagged females trapped near Gueydan were consistent with those of females trapped on Lacassine NWR, and (3) I observed concentrations of radio-tagged females in areas far from my primary trap site.

My telemetry results indicate that LACPOOL is a major diurnal concentration area, accounting for up to 50% of total use by pintails in southwestern Louisiana (Table

5.1). Comparison of peak numbers of pintails counted on Lacassine NWR to those counted throughout southwestern Louisiana verifies the importance of Lacassine NWR to wintering pintails. From winters 1985-86 through 1992-93, Lacassine NWR accounted for 11-59% of the pintail use in southwestern Louisiana (Table 5.2). Because diurnal feeding by pintails on LACPOOL is limited (or non-existent for pintails in large concentrations; Tamisier 1976), the close proximity of LACPOOL to agricultural lands planted in rice or left fallow (idle) may be an important factor influencing its high use by pintails relative to other pools. Rice and fallow agriculture collectively comprised 68-93% of nocturnal pintail use, depending upon time periods and winters (Chapter 4). I found that diurnal use of LACPOOL exceeded that of AMPOOL in 8 of 10 time period and winter combinations. Extensive rice agriculture begins adjacent to LACPOOL and extends 50 km north (Chabreck and Linscombe 1988). In contrast, AMPOOL is separated from extensive rice agriculture by 10 km of primarily marshland (Chabreck and Linscombe 1988). Furthermore, I never located radio-tagged pintails on a permanent, open-water pool on Sabine NWR, which is located in the western third of my study area (Figs. 5.2 and 5.3) where rice and other agricultural production is low (Zapata and Frank 1993). In Mexico, pintails also selected daytime resting areas near rice fields (Migoya et al. 1994).

Pintails used AMPOOL during my study less than I initially expected. Except for LACPOOL, AMPOOL typically contains the highest diurnal concentrations of pintails and other waterfowl in southwestern Louisiana (Chabreck et al. 1989, Tamisier 1976). Unlike LACPOOL and Sabine Pool, which remain flooded throughout the year,



Table 5.2. Peak numbers of northern pintails counted on Lacassine NWR (aerial and ground surveys) and in southwestern Louisiana (aerial surveys) from winters 1985-86 through 1992-93.

Winter	Lacassine NWR <sup>1</sup>	SW Louisiana <sup>2</sup>	% on Lacassine NWR
1985-86	75,000	299,000	25
1986-87	92,000	237,000	39
1987-88	98,000	319,000	31
1988-89	33,000	231,000	14
1989-90	75,000	128,000	59
1990-91	40,000	167,000	24
1991-92	36,000	319,000 *	11
1992-93	30,500	137,000	22

<sup>1</sup>Lacassine National Wildlife Refuge, unpubl. data.

<sup>2</sup>Louisiana Department of Wildlife and Fisheries, unpubl. data.

AMPOOL typically is de-watered during the growing season to encourage growth of moist-soil plants. However, above-average rainfall in spring and summer of 1991 (Muller 1991) prevented managers from draining AMPOOL that year. I suspect that prolonged flooding in 1991 prevented typical growth of plant foods attractive to pintails, with effects that may have lasted into the following year. I recorded a considerable number of diurnal locations in a large area of fresh marsh immediately north of AMPOOL that received very limited hunting (B. Hardeman, Amoco Production Co, pers. comm.; Fig. 5.2). With less plant foods available, pintails may have chosen to roost diurnally on areas closer to agriculture (either north of AMPOOL or on LACPOOL). Regardless, diurnal use of AMPOOL was >2% during 6 of 10 winters and time periods, whereas diurnal use of MINIREF was >2% in only 3 of 10 winters and time periods. I believe that this finding is noteworthy, given that AMPOOL (2168 ha) is much smaller than MINIREF (8143 ha) or LACPOOL (6793 ha).

Rave and Cordes (1993) reported that pintails used mini-refuges only during the day. In contrast, I found that nocturnal use of mini-refuges by female pintails was similar to diurnal use in most time periods and winters, and averaged 2.6% overall. Cox and Afton (1996) reported that mean departure times of evening flights of female pintails from Lacassine NWR ranged from 11 to 25 min post-sunset, depending on cloud cover and moon presence. These flights lasted from 16 to 33 min, on average, depending on age, winter, and date within winters (Cox and Afton 1996). Consequently, many pintails arrive at nocturnal destinations well after dark, when visual observations might be difficult even with the aid of a night-vision scope (Rave and Cordes 1993).

Rave and Cordes (1993) suggested that mini-refuges may be more attractive to pintails than permanent, open-water pools. In contrast, my results indicate that use of mini-refuges by female pintails was low relative to that of pools. Further, I maintain that low use of mini-refuges by female pintails that I observed probably is representative of use during winters prior to my study. Daytime surveys of mini-refuges conducted from 1988-89, the first winter in which mini-refuges were established, through 1990-91 indicate that peak numbers of total ducks (peak numbers for each area in each winter summed) averaged 14,823 (range 8724-19,450; Rave 1989, Parker 1990, Lacassine NWR 1992). Further, Rave (1989) and Parker (1990) reported that pintails ranked fourth in abundance among ducks using mini-refuges. Thus, a crude, but very liberal, estimate of numbers of pintails using mini-refuges diurnally during these winters is  $0.25 \times 14,823 = 3,706$ . Peak numbers of pintails in southwestern Louisiana averaged 211,250 during these winters (Table 5.2). Thus, an overall mean use estimate of mini-refuges during winters prior to my study is  $3,706 / 211,250 = 1.8\%$  (estimates calculated for individual winters ranged from 1.3-3.2%). This figure is similar to my estimates based on telemetry during most time periods ( $\leq 2\%$ ). Diurnal use of mini-refuges by pintails estimated similarly from diurnal surveys in 1991-92 was  $34,257 \times 0.25 / 319,000 = 2.7\%$ , which would fall well within a 95% confidence interval calculated from my telemetry data during SHUNT in that winter (Table 5.1). I conclude that mini-refuges, as currently managed, are not important diurnal roost sites for pintails in southwestern Louisiana. I believe that most discrepancies between my conclusions and those of Rave and Cordes (1993) regarding the importance of mini-refuges in providing refuge and

food to pintails are due to inappropriate methodology (time-activity budgets restricted to mini-refuges) that the latter used to make inferences regarding use of mini-refuges by pintails.

Despite low use of mini-refuges by pintails, I believe that these areas could receive much higher use. Although pintails in southwestern Louisiana rely heavily on agricultural lands for food (Chapter 4), agriculture is limited or non-existent on federal and state refuges in the area. Under certain conditions, I found that pintail use of non-hunted agricultural areas could be high. For example, Lacassine NWR manages a small (362-ha) agricultural portion of the refuge known as the P & H Tract. In 1992-93, this area consisted primarily of rice and fallow agriculture, and was harvested, disked, and flooded just prior to FHUNT. Pintails readily responded to these management practices, and use of this area accounted for 9.6% of total diurnal habitat use during FHUNT in 1992-93 (Cox, unpubl. data). Cover types were similar on the P & H Tract in 1991-92, but stubble was not disked, and flooding was delayed in that winter. Use of the P & H Tract was only 0.9% of total habitat use during FHUNT in 1991-92 (Cox, unpubl. data). I regularly noted other instances in which pintails rapidly relocated to newly flooded habitat throughout the study area. These results are consistent with my general observations that pintails respond rapidly to newly flooded habitats with little residual cover, particularly when these areas are not abundant.

I believe that several features of mini-refuges contributed to low use by pintails. Some mini-refuges were located in portions of my study area that received limited overall use by pintails. For example, I noted generally low use of lands west of

LACPOOL, where 4 mini-refuges were located (Figs. 5.2 and 5.3). Further, the small size and irregularly shaped boundaries of several mini-refuges may preclude extensive use by pintails, particularly when hunting pressure is high on adjacent lands. Despite flooding of 550 ha on mini-refuges by 1 November during 1991-92 of my study (more than in any previous winter; Lacassine NWR 1992), most mini-refuges were dry until rains flooded them concurrently with large amounts of non-refuge agricultural lands throughout the study area. In addition, I observed dense, standing vegetation on several mini-refuges. If increased use of these areas by pintails is a management goal, I recommend that: (1) mini-refuges be located in areas of traditionally high pintail use; (2) size of individual mini-refuges be increased, even if this results in fewer areas included in the program, and boundaries be established such that the perimeter:area ratio is minimized as much as possible; (3) mini-refuges be flooded in early November immediately prior to hunting season, particularly during dry years; and (4) dense, residual crop cover be removed by rolling, disking, or burning.

## LITERATURE CITED

- Aebischer, N. J., P. A. Robertson, and R. E. Kenward. 1993a. Compositional analysis of habitat use from animal radio-tracking data. *Ecology* 74:1313-1325.
- Aebischer, N. J., V. Marcstrom, R. E. Kenward, and M. Karlbom. 1993b. Survival and habitat utilisation: a case for compositional analysis. Pages 343-353 in J. D. Lebreton, and P. M. North, eds. *Marked individuals in the study of bird population*. Birkhauser Verlag Basel, Switzerland.
- Aitchison, J. 1986. *The statistical analysis of compositional data*. Chapman and Hall, London, England. 416 pp.
- Chabreck, R. H., T. Joanen, and S. L. Paulus. 1989. Southern coastal marshes. Pages 249-277 in L. M. Smith, R. L. Pederson, and R. M. Kaminski, eds. *Habitat*

- management for migrating and wintering waterfowl in North America. Texas Tech Univ. Press, Lubbock.
- Chabreck, R. H., and G. Linscombe. 1988. Vegetative map of the Louisiana coastal marshes. Louisiana Dep. of Wildl. and Fisheries, New Orleans.
- Cox, R. R., Jr., and A. D. Afton. 1994. Portable platforms for setting rocket nets in open-water habitats. *J. Field Ornithol.* 65:551-555.
- Cox, R. R., Jr., and A. D. Afton. 1996. Evening flights of female northern pintails from a major roost site. *Condor*: In Press.
- Dwyer, T. J. 1972. An adjustable radio-package for ducks. *Bird-Banding* 43:282-284.
- Friend, M. 1987. Avian cholera. Pages 69-82 in M. Friend, ed. *Field guide to wildlife diseases*. U.S. Fish Wildl. Resour. Publ. 67.
- Gilmer, D. S., L. M. Cowardin, R. L. Duval, L. M. Mechlin, C. W. Shaiffer, and V. B. Kuechle. 1981. Procedures for the use of aircraft in wildlife biotelemetry studies. U.S. Fish Wildl. Serv. Resour. Publ. 140. 19pp.
- Howard, R. J., and H. A. Kantrud. 1986. Habitat suitability models: northern pintail (Gulf Coast wintering). U.S. Fish Wildl. Serv. Biol. Rep. 82(10.121). 16pp.
- Lacassine National Wildlife Refuge. 1992. Southwest Louisiana mini-refuge program, 1990-92. U.S. Fish Wildl. Serv., Lake Arthur, Louisiana. 9pp.
- Migoya, R., G. A. Baldassarre, and M. P. Losito. 1994. Diurnal activity budgets and habitat functions of northern pintail Anas acuta wintering in Sinaloa, Mexico. *Wildfowl* 45:134-146.
- Muller, R. A. 1991. Louisiana monthly climate review: August. Louisiana Office of State Climatology, Louisiana State University, Baton Rouge. 8pp.
- Parker, C. 1990. Annual southwest Louisiana mini-refuge report, 1989-90. U. S. Fish Wildl. Serv., Lacassine Nat. Wildl. Refuge, Lake Arthur, Louisiana. 20pp.
- Rave, D. P. 1989. Waterfowl use of riceland habitats in southwestern Louisiana. Final Rep. Work Unit No. 0606. U.S. Fish Wildl. Serv., Lafayette, Louisiana. 25pp.
- Rave, D. P., and C. L. Cordes. 1993. Time-activity budget of northern pintails using nonhunted rice fields in southwest Louisiana. *J. Field Ornithol.* 64:211-218.

- SAS Institute Inc. 1989. SAS/STAT users guide, version 6, fourth ed., Vol. 2. SAS Institute Inc., Cary, North Carolina. 846pp.
- Tamisier, A. 1976. Diurnal activities of green-winged teal and pintail wintering in Louisiana. *Wildfowl* 27:19-32.
- U.S. Fish and Wildlife Service and Canadian Wildlife Service. 1986. North American waterfowl management plan. U.S. Dep. Inter. and Envir. Canada. 31pp.
- Wolfinger, R. 1992. A tutorial on mixed models. SAS Institute Inc., Cary, North Carolina. 38pp.
- Yakupzack, P. 1988. Wildlife disease contingency plan. Lacassine Nat. Wildl. Ref., Lake Arthur, Louisiana. 23pp.
- Zapata, H. O., and D. Frank. 1993. Agricultural statistics and prices for Louisiana, 1986-1992. Louisiana Agric. Stat. Serv., Dep. of Agric. Econ. and Agribusiness Infor. Ser. No. 116. 73pp.

## **Chapter 6**

### **Effects of Capture and Handling on Survival of Female Northern Pintails**

#### **INTRODUCTION**

Low levels of mortality often occur in telemetry studies of wintering dabbling ducks shortly after they are captured, handled, and released (hereafter, early mortality). Investigators often attribute early mortality to stress associated with capture and handling or to radio-effects (i.e., inability of radio-tagged ducks to adjust to radio-packages). Accordingly, investigators usually exclude from survival analyses deaths occurring from 1 to 5 days following release (e.g., Bergan and Smith 1993, Miller et al. 1995). Decisions on whether to include or exclude early mortalities in survival analyses, and on the length of the “adjustment period” in which ducks are adversely affected by capture, handling, or radio-effects, have thus far been arbitrarily made by researchers.

I noted considerable early mortality of radio-tagged female pintails captured by rocket-netting in southwestern Louisiana during winters 1990-91 through 1992-93. Consequently, I sought to identify factors that influenced early mortality of female pintails. Identification of sources of variation contributing to early mortality has clear management implications for estimating survivorship of waterfowl from all methods in which birds are captured and marked (e.g., leg bands, radio-tags, etc.). My objectives were to: (1) test for variation in survival in relation to age (immature or adult), body condition of females when released, holding time (time from capture until release), number of waterfowl captured in rocket nets, time interval (2-d intervals during the first



10 days of exposure), and flight quality (scored as good, moderate, or poor) of females when released, (2) test for variation in flight quality of females when released in relation to age, holding time, and number of waterfowl captured, and (3) objectively determine the length of time in which females were adversely affected by capture and handling following release.

## STUDY AREA AND METHODS

My study area included all lands within 80 km from the perimeter of Lacassine Pool (Tamisier 1976), and extended 8 km into the Gulf of Mexico. I used rocket nets set on baited and unbaited (loafing) sites to capture female pintails during 22 October-10 November 1990 (plus 1 additional female on 27 Jan 1991), 30 September-27 October 1991, and 4-25 October 1992 (Cox and Afton 1994). Numbers of waterfowl (all species) captured per occasion ( $n = 12$ ) using multiple rocket nets ranged from 6 to 594 ( $\bar{x} \pm sd = 100.9 \pm 162.9$ ).

I aged females as adult or immature using cloacal and wing-feather characteristics (Hochbaum 1942, Carney 1964, Duncan 1985). I weighed ( $\pm 5$  g) each female and measured ( $\pm 0.01$  mm): (1) culmen, (2) bill width (at nares), (3) total tarsus (Dzubin and Cooch 1992), and (4) middle toe length. Before processing birds captured on unbaited sites, I allowed their plumage to dry (ca. 2 h). Most birds captured on baited sites had large amounts of rice (*Oryza sativa*) in their esophagi. I held these birds 6-12 h (overnight for females captured at dusk) before I began processing them (e.g., Conroy et al. 1989). I provided food and water ad libitum to birds while being held. I legbanded and fitted females with 21-g harness radio transmitters (Dwyer 1972). I tightened neck

and body loops so that an index finger (1-cm diameter) fit between the harness and the base of the furcula and keel, respectively, and preened harness loops under the feathers (Houston and Greenwood 1993). I personally inspected and made final adjustments to all harnesses. Radios were equipped with mortality sensors that were activated if transmitters remained motionless for 4 h. 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 aircraft at 1300-1700 m altitudes. I released radio-tagged females during daylight hours at capture sites from 5.7 to 62.9 h ( $\bar{x} \pm \text{sd} = 33.3 \pm 12.2$ ) following capture. To minimize holding time, I released radio-tagged females in batches of 1-39 birds ( $\bar{x} \pm \text{sd} = 14.5 \pm 9.7$ ). Upon release, I tossed each female into the wind and scored her flight as: (1) good -- flight strong and attained good altitude, flew at least 200 m before landing, and showed selectivity in choosing a landing site by circling or flew out of sight, (2) moderate -- flight good and attained moderate altitude, flew 100-200 m before landing, and showed reduced selectivity in choosing a landing site, or (3) poor -- flight weak or visibly interrupted (i.e., skipped wingbeats), attained only low altitude, generally flew <100m before landing, and showed little or no selectivity in choosing a landing site. I attempted to assess status (alive or dead) of radio-tagged females once each day. I immediately retrieved carcasses and transmitters when activated mortality sensors were detected, except for those consumed by alligators (Alligator mississippiensis). Because carcasses were consumed almost entirely, I used predator sign at mortality sites to determine direct cause of death. I attributed direct

cause of death to unknown causes if I found no sign or sign for >1 type of predator at mortality sites.

I developed a body size index using principal components analysis (PROC PRINCOMP; SAS Inst. Inc. 1989) of the correlation matrix of the 4 morphometric variables. I used the first principal component (PC1) scores as a measure of body size (SIZE) for each female (Alisauskas and Ankney 1987). I then regressed (PROC GLM; SAS Inst. Inc. 1989) body mass of females on SIZE, and adjusted each female's body mass for her size by adding the overall mean body mass of all females to her residual from the regression (Ankney and Afton 1988). I used size-adjusted body mass of each female as a measure of condition.

I initially used Cox (1972) proportional hazards regression (PROC PHREG; SAS Inst. Inc. 1996) to test for differences in survival in relation to time (divided into 2-day intervals). No deaths occurred in days 9-10; thus, I combined these days with days 7-8 to allow the partial likelihood to converge (Allison 1995). I used results from this analysis to combine time intervals into periods in which survival did not differ ( $P > 0.05$ ). I then used Cox proportional hazards regression to test for differences in survival in relation to age (adult or immature), condition, holding time, number of waterfowl captured, and time period. I initially included all 2-way interactions in the model, and used backward, stepwise procedures to eliminate non-significant ( $P > 0.05$ ) terms, beginning with the interactions. I compared predicted survival rates from my final fitted model using generalized Chi-square procedures (Sauer and Williams 1989) and PROC

IML (SAS Inst. Inc. 1989). I made multiple comparisons following significant ( $P < 0.05$ ) overall tests using contrasts (Sauer and Williams 1989).

I used a proportional odds model (PROC LOGISTIC; SAS Inst. Inc. 1989) and a generalized logits model (PROC CATMOD; SAS Inst. Inc. 1989) to examine variation in flight quality in relation to holding time, number of waterfowl captured, and age. I initially fit fully specified models (all interactions included), and used backward-stepwise procedures to eliminate non-significant ( $P > 0.05$ ) terms, beginning with the highest-order interactions (Stokes et al. 1995). I neglected to score flight quality for 13 females (11 females captured in the first rocket-net shot in 1990 and 1 additional female in each later winter). For this reason, and also because I considered flight quality to be a response to other covariates in my previous survival analysis (e.g., holding time, number of waterfowl captured, etc.), I tested for variation in survival of females in relation to flight quality in a separate analysis. I again used Cox (1972) proportional hazards regression to test for differences in survival in relation to flight quality (treated as a continuous covariate because of its ordinal nature), time period, and their interaction.

One female was released with an alligator clip attached to the transmitter and later died; I excluded this individual from all analyses. I recovered the radio-packages of 2 females intact, and believe that they escaped unharmed from their harnesses. Three females departed the study area during the first 10 days of exposure. I censored individuals of these types on the last date they were known to have retained radios or been in the study area, respectively.

## RESULTS

### Condition

I radio-tagged 41 (29 ad and 12 imm) females in 1990-91, 154 (96 ad and 58 imm) in 1991-92, and 152 (108 ad and 44 imm) in 1992-93. PC1 explained 49.9% of the overall variation among the 4 morphometric variables. All factor loadings were positive, and ranged from 0.26 (bill width) to 0.61 (middle toe). Body mass of females was positively related to SIZE ( $F = 23.55$ ; 1, 345 df;  $P < 0.0001$ ;  $r^2 = 0.06$ ). The equation was:  $\text{body mass (g)} = 748.8 + 15.9(\text{SIZE})$ .

### Temporal Variation in Survival

Survival of females differed among time periods (Wald  $\chi^2 = 14.37$ ; 3 df;  $P = 0.002$ ). Survival of females during days 1-2 did not differ from that during days 3-4 (Wald  $\chi^2 = 0.26$ ; 1 df;  $P = 0.61$ ), but survival in these periods was lower than in days 5-6 (Wald  $\chi^2 = 5.79$ ; 1 df;  $P = 0.02$  and Wald  $\chi^2 = 4.73$ ; 1 df;  $P = 0.03$ , respectively) and days 7-10 (Wald  $\chi^2 = 9.40$ ; 1 df;  $P = 0.002$  and Wald  $\chi^2 = 8.00$ ; 1 df;  $P = 0.005$ , respectively). Survival did not differ between days 5-6 and days 7-10 (Wald  $\chi^2 = 0.23$ ; 1 df;  $P = 0.63$ ). Accordingly, I pooled 2-day time intervals into 2 time periods (days 1-4 and 5-10) for subsequent analyses.

### Survival in Relation to Age, Condition, Number of Waterfowl Captured, Holding Time, and Time Period

My final fitted model indicated that survival differed in relation to time period (Wald  $\chi^2 = 14.07$ ; 1 df;  $P = 0.0002$ ) and that the effect of holding time on survival differed in relation to the number of waterfowl captured (holding time-by-number of

waterfowl captured interaction; Wald  $\chi^2 = 4.56$ ; 1 df,  $P = 0.03$ ). Effects due to age, condition, and remaining interactions were not significant ( $P > 0.21$  for all tests). The Kaplan-Meier survival rate of females was  $0.933 \pm 0.013$  (SE) during the first 4 days of exposure,  $0.994 \pm 0.004$  in days 5-10 of exposure, and  $0.928 \pm 0.014$  for the 10-day interval (Fig. 6.1). The risk ratio for time period indicated that females were 16 times more likely to die in days 1-4 than in days 5-10. Of 23 female deaths in the first 4 days, I attributed 7 to mammalian predation, 3 to avian predation, 2 to alligator predation, and 11 to unknown causes. I was unable to determine causes of death for 2 additional females that died on days 6 and 8. Survival did not differ in relation to holding time when females were captured with relatively small numbers of waterfowl, but survival declined markedly as holding time increased for females captured with large numbers of waterfowl (Table 6.1). Similarly, survival of females differed in relation to number of waterfowl captured only when holding times exceeded 1.5 days (Table 6.2).

### Flight Quality

Treating flight quality as ordinal, I found weak evidence that the proportional odds assumption was not met (score test from full model;  $\chi^2 = 12.88$ ; 7 df,  $P = 0.08$ ). Accordingly, I subsequently treated flight quality as nominal using a generalized logits model. My final model fit the observed data (likelihood ratio  $\chi^2 = 509.46$ ; 488 df,  $P = 0.24$ ), and indicated that flight quality of females captured with small numbers of waterfowl was not related to holding time, but that of females captured with large numbers of waterfowl declined markedly as holding time increased (holding time-by-

Figure 6.1. Kaplan-Meier survival rate (solid line) and 95% confidence intervals (dashed lines) for female northern pintails during the first 10 days of exposure following capture and handling in southwestern Louisiana during winters 1990-91 through 1992-93.

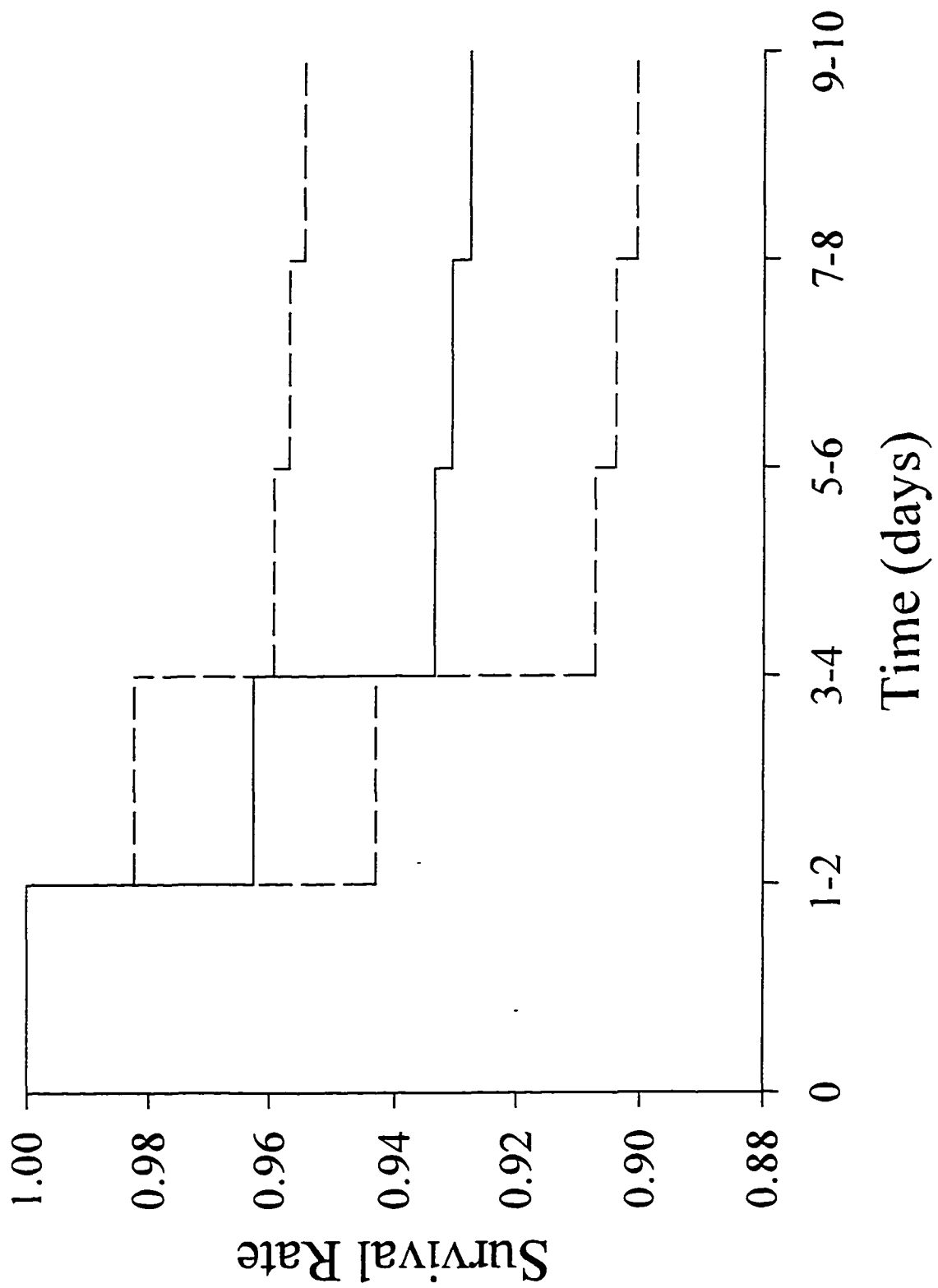




Table 6.1. Predicted survival rates for female northern pintails in southwestern Louisiana (1990-91 through 1992-93) during the first 10 days following capture and handling for values of holding time (days) and numbers of total waterfowl captured in rocket nets.

Number Captured <sup>a</sup>	Holding Time <sup>b</sup>	Survival Rate <sup>c</sup>	SE	<u>P</u> <sup>d</sup>
53	0.91	0.949	0.019	0.83
	1.33	0.959	0.013	
	1.54	0.963	0.013	
172	0.78	0.959	0.016	0.86
	1.72	0.950	0.015	
	2.62	0.939	0.037	
594	0.65	0.989 A	0.015	0.001
	1.41	0.911 B	0.035	
	1.83	0.737 C	0.078	

<sup>a</sup>Number of total waterfowl captured in rocket nets. Values are actual numbers from my sample with a relatively wide range of holding times.

<sup>b</sup>Time from capture until release in days. Values within number captured represent the minimum, mean, and maximum holding times for each level of number captured.

<sup>c</sup>Predicted survival rates within levels of number of waterfowl captured followed by the same letter do not differ ( $P > 0.05$ ) as determined by generalized Chi-square procedures and contrasts.

<sup>d</sup>P-value from generalized Chi-square test that 1 or more predicted survival rates within levels of number of waterfowl captured differ (Sauer and Williams 1989).

Table 6.2. Predicted survival rates for female northern pintails in southwestern Louisiana (1990-91 through 1992-93) during the first 10 days following capture and handling for values of number of total waterfowl captured in rocket nets and holding time.

Holding Time <sup>a</sup>	Number Captured <sup>b</sup>	Survival Rate <sup>c</sup>	SE	<u>P</u> <sup>d</sup>
0.91	53	0.949	0.019	0.63
	172	0.958	0.015	
	594	0.977	0.022	
1.33	53	0.959	0.016	0.70
	172	0.954	0.012	
	594	0.928	0.034	
1.54	53	0.963 A	0.013	0.06
	172	0.952 A	0.013	
	594	0.874 B	0.036	

<sup>a</sup>Time from capture until release in days. Listed holding times were within the range of actual holding times for each level of number of total waterfowl captured.

<sup>b</sup>Number of total waterfowl captured in rocket nets. Values are actual numbers from my sample with a relatively wide range of holding times.

<sup>c</sup>Predicted survival rates within levels of number of waterfowl captured followed by the same letter do not differ ( $P > 0.05$ ) as determined by generalized Chi-square procedures and contrasts.

<sup>d</sup>P-value from generalized Chi-square test that 1 or more predicted survival rates within levels of holding time differ.

number of waterfowl captured interaction;  $\chi^2 = 8.06$ ; 2 df;  $P = 0.02$ ; Fig. 6.2). Effects due to age and other interactions were not significant ( $P > 0.11$  for all tests).

My final fitted model testing for differences in survival in relation to flight quality and time period indicated that survival was positively related (Wald  $\chi^2 = 7.18$ ; 1 df;  $P = 0.007$ ) to flight quality, and that survival was lower (Wald  $\chi^2 = 13.76$ ; 1 df;  $P = 0.0002$ ) during the first 4 days of exposure than in days 5-10. The interaction between flight quality and time period was not significant (Wald  $\chi^2 = 0.60$ ; 1 df;  $P = 0.44$ ). The risk ratio for flight quality indicated that females whose flight quality was scored as less than good were twice as likely to die during the 10-day interval than those scored in the next higher level of flight quality. Similar to my previous analysis, the risk ratio for time period indicated that females were over 15 times more likely to die in days 1-4 than in days 5-10.

## DISCUSSION

I was unable to necropsy dead females because little remained of carcasses, and many carcasses appeared to have been scavenged. The fact that I never found intact carcasses suggests that most, if not all, females that died during the first 4 days of exposure were killed by predators, and that factors related to capture, handling, or radio-packages were not the direct cause of death. The greater incidence of early mortality in my study relative to most others using harness transmitters (indexed by number of mortalities excluded from survival analyses; Table 6.3) suggests that radio-effects were not responsible for most deaths that I observed. Capture myopathy is a condition in which intense muscular exertion and trauma associated with restraint leads to an acute

Figure 6.2. Predicted flight quality of female northern pintails upon release in southwestern Louisiana in relation to holding time for various levels of number of waterfowl captured (solid lines = 53, dashed lines = 172, dotted lines = 594). Y-axis of top graph is probability of flight quality being scored as moderate vs. poor, and Y-axis of bottom graph is probability of flight quality being scored as good vs. poor.

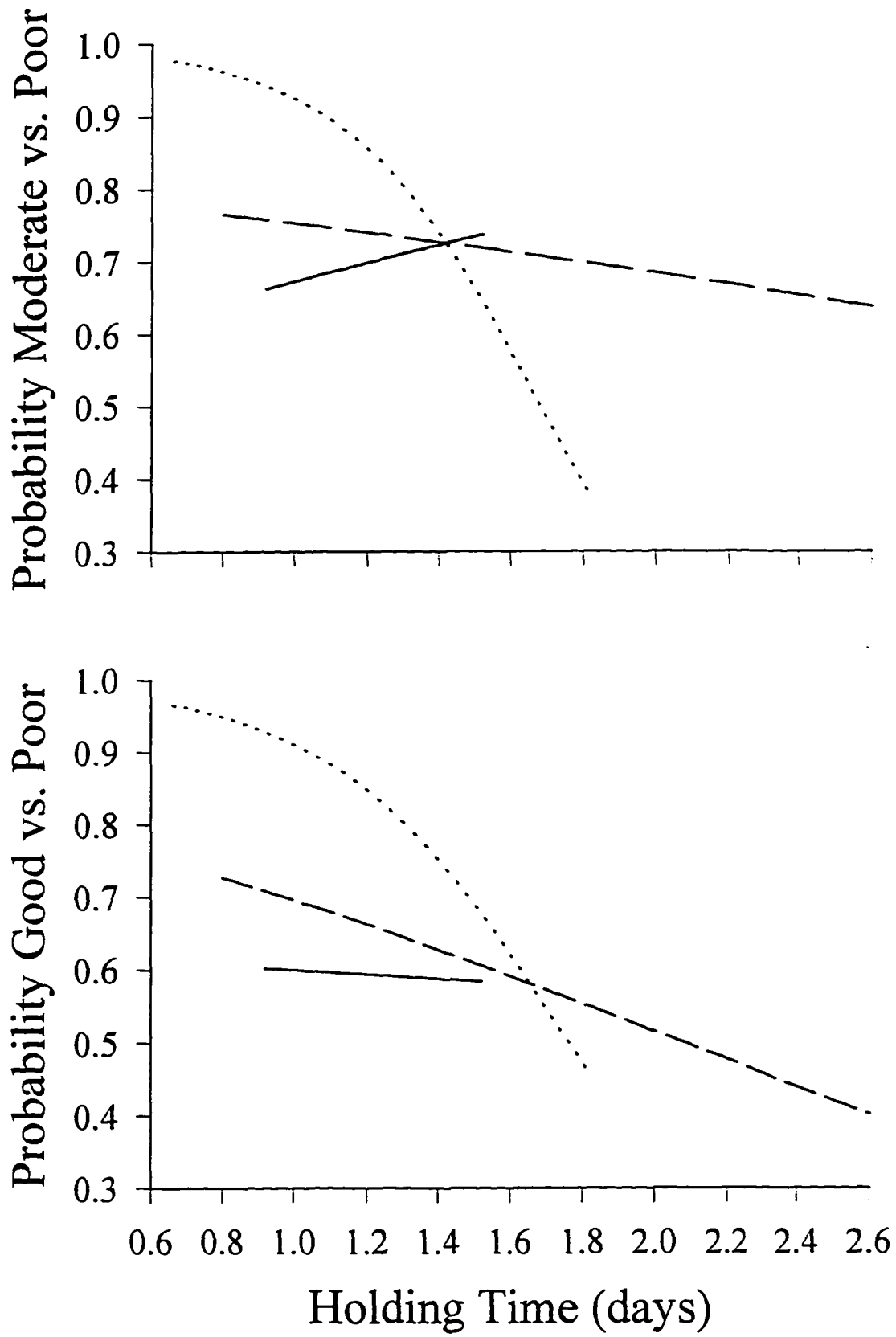


Table 6.3. Capture method, holding time (h), number of birds radio-tagged, number of mortalities excluded from survival analysis, and length of adjustment period (d) for wintering dabbling ducks equipped with harness transmitters.

Species	Capture Method	Holding Time	Number Tagged	Excluded Mortalities	Adjustment Period	Authority
northern pintail	rocket nets	6-63	347	23	4	this study
northern pintail	rocket nets	<14	170	1	2	Migoya and Baldassarre 1995
northern pintail	rocket nets, bait traps	<12	191	1	5	Miller et al. 1995
northern pintail	rocket nets	<1-19	433	14	6	J. P. Fleskes, pers. comm.
northern pintail	rocket nets	<12	194	9	5	M. R. Miller, pers. comm.
mallard	rocket nets, bait traps	4-6 <sup>a</sup>	100	0	3	Dugger et al. 1994
mallard	bait traps	6-14	183	30 <sup>b</sup>	1	Bergan and Smith 1993
mallard	-----	----	223	---	---	Reinecke et al. 1987
American black duck	rocket nets	3-12 <sup>a</sup>	106	0	0	Longcore et al. 1991
American black duck	bait traps	8-12 <sup>a</sup>	243	16 <sup>b</sup>	2	Conroy et al. 1989

<sup>a</sup>Holding time reported as number of hours until processing; otherwise, holding time is time held from capture until release.

<sup>b</sup>Includes birds excluded for survival analysis for reasons other than mortality, e.g., emigration, radio failure, etc.

degeneration of muscle tissue (Dabbert and Powell 1993). In extreme cases of capture myopathy, waterfowl are unable to fly (Wobeser 1981). Blood enzymes indicative of capture myopathy increase as mallards spend greater lengths of time struggling under rocket nets (Bollinger et al. 1989, Dabbert and Powell 1993). Although I did not record the time that birds spent under nets prior to removal in my study, I am confident that time spent by female pintails under nets increased, on average, as numbers of waterfowl captured increased. Thus, my results that holding time affected flight quality and survival only for females captured with large numbers of waterfowl, and that survival of females was positively related to flight quality, are consistent with the hypothesis that early mortality was related to capture myopathy in my study. However, I have no direct evidence that capture myopathy contributed to early mortalities; thus, other physiological factors related to stress (e.g., adrenal corticotropic hormones) may have been partly, or totally, responsible for the early mortality that I observed.

Aside from increased time spent under nets, I believe that an additional complicating factor associated with capturing very large numbers of waterfowl may affect survival. I captured 594 waterfowl in 3 nets in my final and largest rocket-net shot. I observed that ducks could freely move under 2 nets that contained the most waterfowl, and that ducks moved as a group under the nets while attempting to escape. Of 102 females instrumented from this rocket-net shot, 13 (12.9%) died in the first 4 days of exposure. Thus, the greater freedom of movement permitted by very large numbers of waterfowl under rocket nets may increase incidence of injury or encourage greater exertion compared to smaller captures. However, because my results that flight

quality and survival were related to number of waterfowl captured were influenced largely by this single event, these findings may be spurious, and consequently should be interpreted with caution.

Incidence of early mortality in my study was greater than in other telemetry studies of wintering dabbling ducks (Table 6.3). Although numbers of waterfowl captured were not reported by researchers using rocket nets, I suspect that numbers of waterfowl captured per rocket-netting event were higher in my study than in most others. Clearly, holding times were greater in my study than in others (Table 6.3). Therefore, my finding that the interaction of number of waterfowl captured and holding time was an important predictor of early mortality appears consistent with the greater incidence of early mortality in my study relative to others.

My finding that holding time interacted with number of waterfowl captured to affect survival soon after release also is consistent with incidence of early mortality in other studies of wintering pintails (Table 6.3). J. P. Fleskes and M. R. Miller (pers. comms.) observed incidence of early mortality approaching that observed in my study. Fleskes (pers. comm.) reported that 14 of 433 female pintails (all captured by rocket-netting, including several captures of >100 waterfowl) failed to adjust to harness transmitters as evidenced by their failure to make feeding flights, and that all of these were killed by predators in the first 6 days of exposure. Miller (pers. comm.) reported that 9 of 194 female pintails (all captured by by rocket-netting, including several captures of >200 pintails) were killed by predators within 4 days after release in Suisun Marsh, California. Thus, my results are similar in that: (1) most early mortality occurred very



soon after release, (2) early mortality of female pintails was related to impaired flight capability, (3) relatively large numbers (>100) of waterfowl were captured frequently, and (4) in cases where cause of death could be determined, all early mortalities were attributed to predation. In contrast, Migoya and Baldassarre (1995) and Miller et al. (1995), rarely captured >50 total waterfowl in rocket nets, and holding times in these studies were <14 h (R. Migoya and M. R. Miller, pers comms.). Thus, incidence of early mortality of wintering female pintails generally appears to be positively related to an interaction between holding time and number of waterfowl captured.

Predicted incidences of early mortality related to capture and handling for females captured in small groups or with short holding times in my study (Tables 6.1 and 6.2) are higher than that observed in most studies of wintering waterfowl (Table 6.3). I observed mink (Mustela vison), raccoons (Procyon lotor), coyotes (Canis latrans), northern harriers (Circus cyaneus), red-tailed hawks (Buteo jamaicensis), and peregrine falcons (Falco peregrinus) on my release sites, the latter 3 of which also were observed frequently near pintails in other locales in southwestern Louisiana (Rave and Cordes 1993). Raccoons, in particular, were so numerous at my bait sites that they were a nuisance. I delayed or refrained from firing rocket nets on several occasions because raccoons were present, and I captured raccoons coincident with ducks on 2 other occasions. I attempted to use bait traps to capture waterfowl on 1 occasion, and a predator killed approximately half of 30 captured blue-winged teal (Anas discors) in the trap. I decided against further use of bait traps because I believed predator densities were too high. My more frequent sightings of potential predators suggest that predator

densities, at least mammalian, were greater at my pintail release sites than at those in California (J. P. Fleskes and M. R. Miller, pers. comms.) or Mexico (R. Migoya, pers. comm.). Thus, greater predator densities may have contributed to the greater incidence of early mortality in my study relative to others.

Incidence of early mortality was over 16 times higher in the first 4 days of exposure than in days 5-10 in my study. I conclude that a 4-day "adjustment period" is most appropriate for my sample of radio-tagged pintails prior to considering them at risk for subsequent survival analysis.

## **RESEARCH AND MANAGEMENT IMPLICATIONS**

I strongly recommend that investigators monitor radio-tagged waterfowl closely (at least once but preferably twice or more each day) for several days following release. I further recommend that future studies test for differences in incidence of early mortality and capture myopathy in pintails and other waterfowl immediately following instrumentation and release in relation to capture method (particularly between bait traps and rocket nets), time spent in rocket nets prior to removal, holding time, and types of radio-packages (e.g., implants, glue and suture, and harness transmitters). I caution managers and researchers that capturing very large numbers of waterfowl in rocket nets may increase the incidence of early mortality. Further, I recommend that holding times of waterfowl be minimized, particularly when large numbers are captured, by processing birds after allowing only enough time for their plumage to dry. Body mass of individuals retaining food in their esophagi after their plumage had dried could be adjusted by estimating the volume of food retained and comparing it to similar volumes of known

mass (Albright 1981). Finally, I encourage investigators observing notable early mortality to consider statistical analyses as an objective tool for determining the length of time in which waterfowl are at abnormally high risk from capture, handling, or radio-transmitter effects.

## LITERATURE CITED

- Albright, J. J. 1981. Behavioral and physiological responses of coastal-wintering black ducks (*Anas rubripes*) to changing weather in Maine. M.S. Thesis, Univ. Maine, Orono. 72pp.
- Alisauskas, R. T., and C. D. Ankney. 1987. Age-related variation in the nutrient reserves of breeding American coots (*Fulica americana*). *Can. J. Zool.* 65:2417-2420.
- Allison, P. D. 1995. Survival analysis using the SAS system: a practical guide. SAS Inst. Inc., Cary, N.C. 292pp.
- Ankney, C. D., and A. D. Afton. 1988. Bioenergetics of breeding northern shovelers: diet, nutrient reserves, clutch size, and incubation. *Condor* 90:459-472.
- Bergan, J. F., and L. M. Smith. 1993. Survival rates of female mallards wintering in the Playa Lakes Region. *J. Wildl. Manage.* 57:570-577.
- Bollinger, T., G. Wobeser, R. G. Clark, D. J. Nieman, and J. R. Smith. 1989. Concentration of creatine kinase and aspartate aminotransferase in the blood of wild mallards following capture by three methods for banding. *J. Wildl. Dis.* 25:225-231.
- Carney, S. M. 1964. Preliminary keys to waterfowl age and sex identification by means of wing plumage. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Wildl. 82. 47pp.
- Conroy, M. J., G. R. Costanzo, and D. B. Stotts. 1989. Winter survival of female American black ducks on the Atlantic Coast. *J. Wildl. Manage.* 53:99-109.
- Cox, D. R. 1972. Regression models and life-tables (with discussion). *J. R. Stat. Soc. Ser. B* 34:187-220.
- Cox, R. R., Jr., and A. D. Afton. 1994. Portable platforms for setting rocket nets in open-water habitats. *J. Field Ornithol.* 65:551-555.

- Dabbert, C. B., and K. C. Powell. 1993. Serum enzymes as indicators of capture myopathy in mallards (Anas platyrhynchos). J. Wildl. Dis. 29:304-309.
- Dugger, B. D., K. J. Reinecke, and L. H. Fredrickson. 1994. Late winter survival of female mallards in Arkansas. J. Wildl. Manage. 58:94-99.
- Duncan, D. C. 1985. Differentiating yearling from adult northern pintails by wing-feather characteristics. J. Wildl. Manage. 49:576-579.
- Dwyer, T. J. 1972. An adjustable radio-package for ducks. Bird-Banding 43:282-284.
- Dzubin, A., and E. G. Cooch. 1992. Measurements of geese: general field methods. California Waterfowl Assoc., Sacramento. 20pp.
- Hochbaum, H. A. 1942. Sex and age determination of waterfowl by cloacal examination. Trans. North Am. Wildl. Conf. 7:299-307.
- Houston, R. A., and R. J. Greenwood. 1993. Effects of radio transmitters on nesting captive mallards. J. Wildl. Manage. 57:703-709.
- Longcore, J. R., D. G. McAuley, and C. Frazer. 1991. Survival of postfledging female American black ducks. J. Wildl. Manage. 55:573-580.
- Migoya, R., and G. A. Baldassarre. 1995. Winter survival of female northern pintails in Sinaloa, Mexico. J. Wildl. Manage. 59:16-22.
- Miller, M. R., J. P. Fleskes, D. L. Orthmeyer, W. E. Newton, and D. S. Gilmer. 1995. Survival of adult female northern pintails in Sacramento Valley, California. J. Wildl. Manage. 59:478-486.
- Rave, D. P., and C. L. Cordes. 1993. Time-activity budgets of northern pintails using nonhunted rice fields in southwest Louisiana. J. Field Ornithol. 64:211-218.
- Reinecke, K. J., C. W. Shaiffer, and D. Delnicke. 1987. Winter survival of female mallards in the lower Mississippi Valley. Trans. North Am. Wildl. Nat. Resour. Conf. 52:258-263.
- SAS Inst. Inc. 1989. SAS/STAT User's Guide, Version 6, Fourth ed., Vol. 2. SAS Inst. Inc., Cary, N.C. 846pp.
- SAS Inst. Inc. 1996. SAS/STAT software: changes and enhancements through release 6.11. SAS Inst. Inc., Cary N.C. 1080pp.

- Sauer, J. R., and B. K. Williams. 1989. Generalized procedures for testing hypotheses about survival or recovery rates. *J. Wildl. Manage.* 53:137-142.
- Stokes, M. E., C. S. Davis, and G. G. Koch. 1995. Categorical data analysis using the SAS system. SAS Inst. Inc., Cary N.C. 499pp.
- Tamisier, A. 1976. Diurnal activities of green-winged teal and pintail wintering in Louisiana. *Wildfowl* 27:19-32.
- Wobeser, G. A. 1981. Diseases of wild waterfowl. Plenum Press, New York. 300pp.

## Chapter 7

### Survival of Female Northern Pintails Wintering in Southwestern Louisiana

#### INTRODUCTION

North American populations of northern pintails (Anas acuta, hereafter pintails) have declined markedly from levels recorded during the 1970s. Numbers of breeding pintails reached record lows in 1984 (3.0 million), 1985 (2.5 million), 1988 (2.0 million) and 1991 (1.8 million; U. S. Fish and Wildlife Service [USFWS] and Canadian Wildlife Service [CWS] 1996). Despite a 45% increase in pintail breeding numbers in 1994 from the previous year, numbers in 1996 (2.7 million) were unchanged from 1995, 38% below long-term average, and 57% below goals of the North American Waterfowl Management Plan (NAWMP; USFWS and CWS 1986, USFWS and CWS 1996).

The Gulf Coasts of Texas and Louisiana host some of the largest concentrations of pintails wintering in the Central and Mississippi Flyways (Howard and Kantrud 1986). Numbers of pintails counted during mid-winter surveys from 1950-1987 ranged from 0.25-1.8 million in Texas and from 0.22-1.4 million in Louisiana (Hestbeck 1993a). Using winter banding data, Hestbeck (1993a) found that pintails winter in distinct populations, and that the Texas-Louisiana Gulf Coast was among the regions to which pintails showed the highest fidelity among winters. Hestbeck (1993b) indicated that further investigation of relationships between management of wintering areas and survival and population size of pintails was a research priority.

Survival estimation from banding data does not allow mortality to be partitioned into portions of the annual cycle, nor identification of causes of natural mortality. I

estimated winter survival rates of adult (after hatching yr) and immature (hatching yr) female pintails radio-tagged in southwestern Louisiana. Further, I tested for variation in survival rates in relation to age, winter, body condition at the time of capture, time period in relation to duck hunting seasons, and region (southwestern Louisiana or elsewhere on the Louisiana-Texas Gulf Coast and Mississippi Alluvial Valley).

## **STUDY AREA AND METHODS**

### **Field Procedures**

My primary study area included all lands within 80 km from the perimeter of Lacassine Pool (Tamisier 1976), and extended 8 km into the Gulf of Mexico (Fig. 7.1). I captured female pintails in southwestern Louisiana using rocket nets during 22 October-10 November 1990 (plus 1 additional female on 27 Jan 1991), 30 September-27 October 1991, and 4-25 October 1992. I previously described trap sites and capture methods (Cox and Afton 1994, Chapter 6).

I aged females as adult or immature using cloacal and wing-feather characteristics (Hochbaum 1942, Carney 1964, Duncan 1985). I weighed ( $\pm 5$  g) each female and measured ( $\pm 0.01$  mm): (1) culmen, (2) bill width (at nares), (3) total tarsus (Dzubin and Cooch 1992), and (4) middle toe length. I legbanded and fitted females with 21-g backpack-type radio transmitters (Dwyer 1972) that had mortality sensors and expected lives of either 100 days (1990-91) or 150 days (1991-92 and 1992-93). I previously described handling procedures (Chapter 6). Transmitters initially had minimum ground-to-ground ranges of 7 km to truck-mounted 4-element null-peak antennas, and ground-to-air ranges of 60 km to aircraft at 1300-1700 m altitudes. The ventral side of each

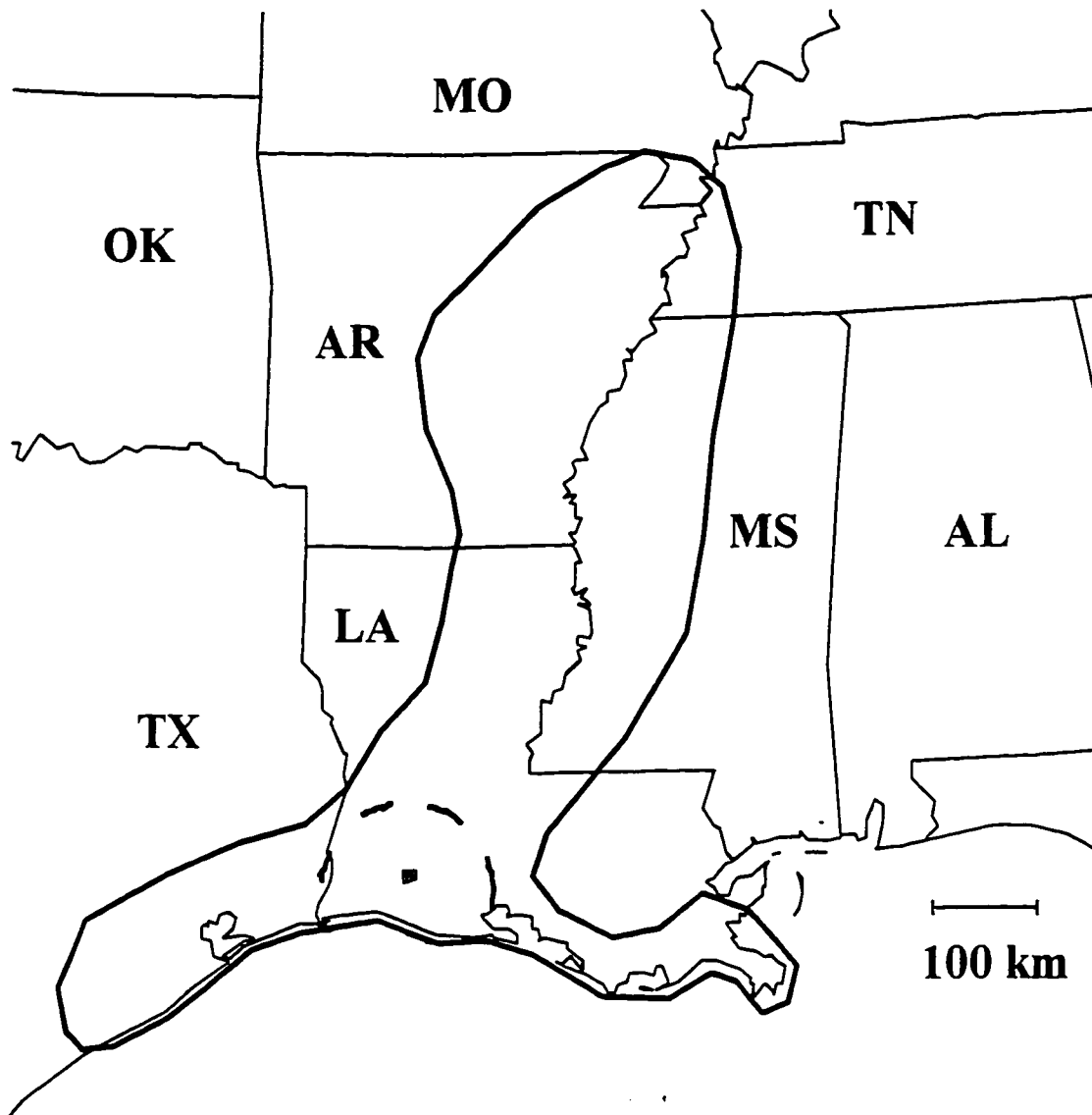


Figure 7.1. Study area in which radio-tagged female northern pintails were monitored, 1990-91 through 1992-93. Dashed area in southwestern Louisiana is primary study area; hatched polygon is Lacassine Pool.



transmitter was labeled with instructions for hunters to notify me by phone to receive a reward (pen-and-ink print).

I attempted to assess status (alive or dead) of radio-tagged females once each day within my study area during 26 October 1990-26 February 1991, 5 October 1991-19 February 1992, and 8 October 1992-28 February 1993. Each day that weather permitted, I used aircraft to search the entire primary study area (Gilmer et al. 1981). On days when weather prohibited use of aircraft, I assessed status using 3 ground vehicles and permanent towers established at concentration areas. At 1-4 week intervals, I used aircraft to determine status of radio-tagged pintails located outside my primary study area, including much of the remainder of Louisiana, eastern Arkansas, western Mississippi and Tennessee, southeastern Missouri, and the rice-prairie region and Gulf Coast of Texas to Matagorda Bay (Fig. 7.1). I immediately retrieved carcasses and transmitters when activated mortality sensors were detected, except that transmitters in deep water with unconsolidated substrates sometimes required multiple attempts (up to 2 days delay in retrieval). I sent recovered carcasses to the National Wildlife Health Research Center for necropsy when cause of death was not obvious.

#### Analysis

Body Size and Condition.--I performed principal components analysis (PROC PRINCOMP; SAS Inst. Inc. 1989) on the correlation matrix of the 4 morphometric variables from all instrumented females. I subsequently used PC1 scores as a measure of body size (SIZE) for each female (Alisauskas and Ankney 1987). I then used least-squares regression (PROC GLM; SAS Inst. Inc. 1989) to test for a relationship between

body mass and SIZE of females. I adjusted body mass of each female for her SIZE by adding the overall mean body mass of females to her residual from the regression (Ankney and Afton 1988). I subsequently used size-adjusted body mass of each female at the time of capture as a measure of condition. I used 2-way ANOVA (PROC GLM; SAS Inst. Inc. 1989) to test for differences in condition in relation to age, winters, and their interaction. I used Fisher's LSD to compare means of significant ( $P < 0.05$ ) effects.

Survival.--Duck hunting seasons in my primary study area were split into 2 seasons (30 days total length) each winter during which hunters could shoot 1 pintail of either sex. I divided each winter into 5 time periods based on duck hunting seasons: (1) pre-hunting season ([PRE]; 26 Oct-16 Nov 1990, 5 Oct-15 Nov 1991, and 8 Oct-20 Nov 1992), (2) first hunting season ([FHUNT]; 17 Nov-5 Dec 1990, 16 Nov-6 Dec 1991, and 21 Nov-5 Dec 1992), (3) time between split hunting seasons ([SPLIT]; 6-26 Dec 1990, 7-27 Dec 1991, and 6-25 Dec 1992), (4) second hunting season ([SHUNT]; 27 Dec 1990-6 Jan 1991, 28 Dec 1991-5 Jan 1992, and 26 Dec 1992-9 Jan 1993), and (5) post-hunting season ([POST]; 7 Jan-26 Feb 1991, 6 Jan-19 Feb 1992, and 10 Jan-28 Feb 1993).

Movements of radio-tagged pintails outside of my primary study area were frequent and far-ranging (R. R. Cox, unpubl. data). Because I monitored status of females located outside my primary study area less frequently than those located inside, I believe that the probability of detection of natural mortality was lower outside the primary study area. Therefore, I performed 2 survival analyses. First, I considered survival from all forms of mortality (hunting and non-hunting) only within my primary

study area. I used Cox (1972) proportional hazards regression (PROC PHREG; SAS Inst. Inc. 1996) to test for differences in survival in relation to age (adult or immature), winter (1990-91, 1991-92, or 1992-93), time period (PRE, FHUNT, SPLIT, SHUNT, or POST), and condition at capture. In this model, I right-censored birds while they were outside the study area, and re-included them in the risk set if they returned later. I initially included all 2-way interactions in the model, and used backward, stepwise procedures to eliminate non-significant ( $P > 0.05$ ) terms, beginning with the least significant interactions. However, because condition was partially confounded with age and winter (see Results), I further tested for condition effects by including it as a single predictor of survival.

In my second analysis, I considered survival inside and outside the primary study area, but considered confirmed cases of legal hunting as the only source of mortality. In this model, I right-censored females that died from non-hunting sources of mortality on their dates of death. I used proportional hazards regression to test for differences in survival in relation to age, winter, condition, and region (in or out of the primary study area). I again included all 2-way interactions initially, and used backward, stepwise procedures to eliminate non-significant terms. I also further tested for body condition effects in this analysis by including condition as a single predictor of survival.

I observed relatively high rates of mortality during the first 4 days of exposure which I attributed to stress from capture and handling (Chapter 6). Accordingly, I excluded the first 4 days of exposure for all females from analyses in this paper. Important predictors of mortality during the first 4 days of exposure were number of

waterfowl captured in rocket nets, holding time (time from capture until release), and flight quality (scored as good, moderate, or poor) of females upon release (Chapter 6). I tested for chronic effects of capture and handling on survival past the initial 4 days of exposure (within the primary study area considering all sources of mortality) using proportional hazards regression, and found no evidence that survival differed in relation to number of waterfowl captured (Wald  $\chi^2 = 0.88$ ; 1 df;  $P = 0.35$ ), holding time (Wald  $\chi^2 = 0.05$ ; 1 df;  $P = 0.83$ ), or their interaction (Wald  $\chi^2 = 0.22$ ; 1 df;  $P = 0.64$ ), or among levels of flight quality (Wald  $\chi^2 = 0.02$ ; 1 df;  $P = 0.88$ ).

When the date of death was not known precisely, I estimated it as the midpoint between the last date noted alive and the first date the transmitter was detected running in mortality mode. When the date that a female departed the primary study area was not known precisely, I randomly selected a date from the interval between the last date the bird was known to be in the study area and the first date the bird was missed within the study area or known to be outside the study area. I estimated dates for birds returning to the primary study area similarly when exact dates were not known. Two females were shot and reported to me by hunters after their transmitters had failed; I right-censored these individuals following the last radio contact. I excluded from all analyses one additional female that was released with an alligator clip attached to the transmitter harness and later died.

## RESULTS

### Body Size and Condition

PC1 explained 49.9% of the overall variation among the 4 morphometric variables. All factor loadings were positive, and ranged from 0.26 (bill width) to 0.61 (middle toe). Body mass of females was positively related to SIZE ( $F = 23.55$ ; 1, 345 df;  $P < 0.0001$ ;  $r^2 = 0.06$ ). The equation was: body mass (g) =  $748.8 + 15.9(\text{SIZE})$ . Female condition differed among winters ( $F = 18.21$ ; 2, 341 df;  $P < 0.0001$ ) and between ages ( $F = 16.65$ ; 1, 341 df;  $P < 0.0001$ ), but the winter-by-age interaction was not significant ( $F < 0.01$ ; 2, 341 df;  $P > 0.99$ ). Condition of females was highest in 1990-91 ( $\bar{x} \pm \text{SE} = 796.6 \pm 12.4$ ), intermediate in 1992-93 ( $\bar{x} \pm \text{SE} = 740.3 \pm 6.6$ ), and lowest in 1991-92 ( $\bar{x} \pm \text{SE} = 709.0 \pm 6.4$ ;  $P_s < 0.0007$ ). Adults ( $\bar{x} \pm \text{SE} = 771.1 \pm 5.8$ ) were in better condition than immatures ( $\bar{x} \pm \text{SE} = 726.2 \pm 8.0$ ).

### Survival in Southwestern Louisiana - All Sources of Mortality

This analysis included 320 of 347 females that I radio-tagged. Females in the first 4 days of exposure that: (1) died ( $n = 23$ ), (2) slipped transmitters ( $n = 1$ ), (3) departed my primary study area and never returned ( $n = 2$ ), or (4) I lost contact with ( $n = 1$ ), were not included in the analysis. My final fitted model contained only age (Wald  $\chi^2 = 5.48$ ; 1 df;  $P = 0.019$ ) and time-period (Wald  $\chi^2 = 23.30$ ; 4 df;  $P < 0.0001$ ) effects. Effects due to winter, condition, and all interactions were not significant ( $P > 0.12$  for all tests). When I tested for condition effects alone on survival, I found no relation to condition (Wald  $\chi^2 = 1.37$ ; 1 df;  $P = 0.24$ ). The risk ratio indicated that immatures were 1.8 times more likely to die during the wintering period than were adults. Female

survival was lower during hunting than during non-hunting seasons ( $P < 0.006$  for all tests), whereas survival did not differ between FHUNT and SHUNT ( $P = 0.58$ ) or among non-hunting seasons ( $P > 0.25$  for all tests; Table 7.1). The risk ratios indicated that females were 20.9 and 17.6 times more likely to die during FHUNT and SHUNT, respectively, than during POST. The overall survival rate for the 146-day period from 5 October-28 February was  $0.714 \pm 0.045$  (SE) for adults and  $0.550 \pm 0.068$  (SE) for immatures (Fig. 7.2). Of 70 deaths, I confirmed that 43 (61%) were due to legal hunting, 2 (3%) were believed to be due to legal hunting (transmitters were found near duck blinds or hunting camps with harnesses stretched as if removed by hunters), 1 (1%) was shot illegally, 6 (9%) were killed by mammalian predators, 2 (3%) were killed by avian predators, and 16 (23%) were due to unknown causes.

#### Survival In and Out of Primary Study Area - Hunting Mortality Only

This analysis included 322 radio-tagged females, including all those in the previous analysis plus the 2 females that departed the primary study area in the first 4 days of exposure and never returned. My final fitted model contained only age effects (Wald  $\chi^2 = 11.69$ ; 1 df;  $P = 0.0006$ ). Effects due to winter, condition, region, and all interactions were not significant ( $P > 0.13$  for all tests). When I tested for condition effects alone, I found no relation to condition (Wald  $\chi^2 = 1.44$ ; 1 df;  $P = 0.23$ ).

Immatures were 2.6 times more likely to be shot by hunters than were adults. The overall survival rate, considering confirmed cases of hunting mortality only, was  $0.870 \pm 0.025$  (SE) for adults and  $0.713 \pm 0.046$  (SE) for immatures (Fig. 7.3).

Table 7.1. Estimated survival, hunting mortality, and non-hunting mortality rates by age for female northern pintails in southwestern Louisiana during winters 1990-91 through 1992-93 for each time period and overall (5 October-28 February).

Time Period <sup>a</sup>	Days <sup>b</sup>	Age	Survival Rate <sup>c</sup>		Hunting Mortality Rate		Non-hunting Mortality Rate	
			$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
PRE	47	Adult	0.968	0.013	0	0	0.032	0.013
		Immature	0.980	0.014	0	0	0.020	0.014
FHUNT	21	Adult	0.878	0.027	0.095	0.024 <sup>d</sup>	0.030	0.015
		Immature	0.756	0.049	0.223	0.047	0.027	0.019
SPLIT	21	Adult	0.973	0.015	0.018	0.013 <sup>e</sup>	0.009	0.009
		Immature	0.983	0.017	0	0	0.017	0.017
SHUNT	15	Adult	0.887	0.047	0.083	0.038	0.033	0.032
		Immature	0.799	0.064	0.146	0.060	0.065	0.036
POST	50	Adult	0.929	0.040	0	0	0.071	0.040
		Immature	0.957	0.042	0	0	0.043	0.042
OVERALL	146	Adult	0.714	0.045	0.165	0.034	0.145	0.042
		Immature	0.550	0.068	0.315	0.053	0.196	0.077

<sup>a</sup>PRE = pre-hunting season; FHUNT = first hunting season; SPLIT = time between split hunting seasons; SHUNT = second hunting season; POST = post-hunting season.

<sup>b</sup>Maximum number of days per time period in any winter.

<sup>c</sup>Note that hunting mortality rate and non-hunting mortality rate cannot be summed to estimate mortality rate from both sources (1 - survival rate).

<sup>d</sup>Includes 1 suspected hunter-killed female.

<sup>e</sup>Includes 1 suspected hunter-killed female and 1 illegally killed female.

Figure 7.2. Survival rate (5 Oct-28 Feb = 146 days) of radio-tagged female northern pintails (adults = circles; immatures = squares) in southwestern Louisiana during winters 1990-91 through 1992-93, considering all sources of mortality. Dashed and dotted lines are 95% confidence intervals for adults and immatures, respectively. Maximum widths of first hunting seasons (FHUNT) and second hunting seasons (SHUNT) among winters are denoted by vertical lines.



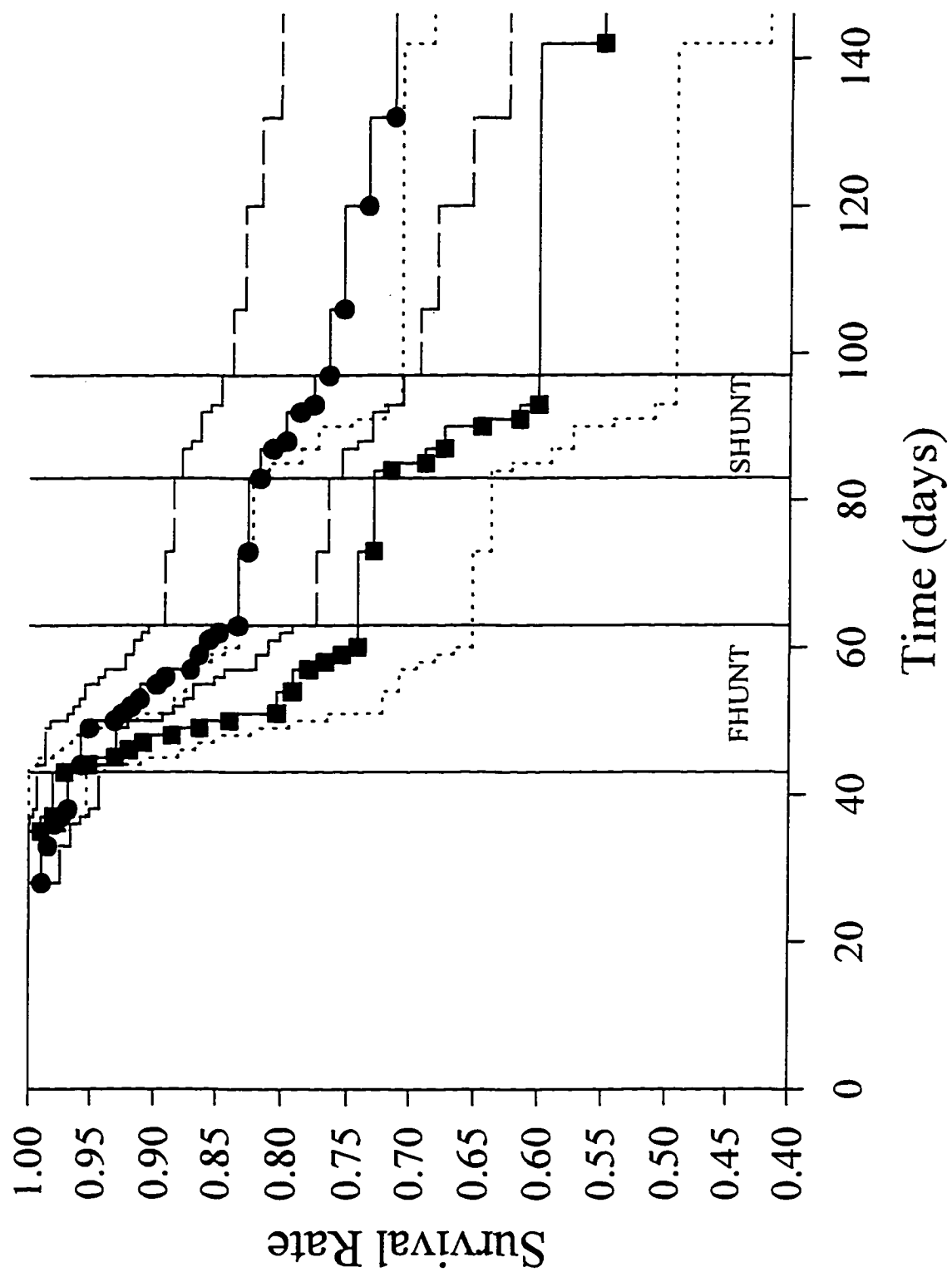
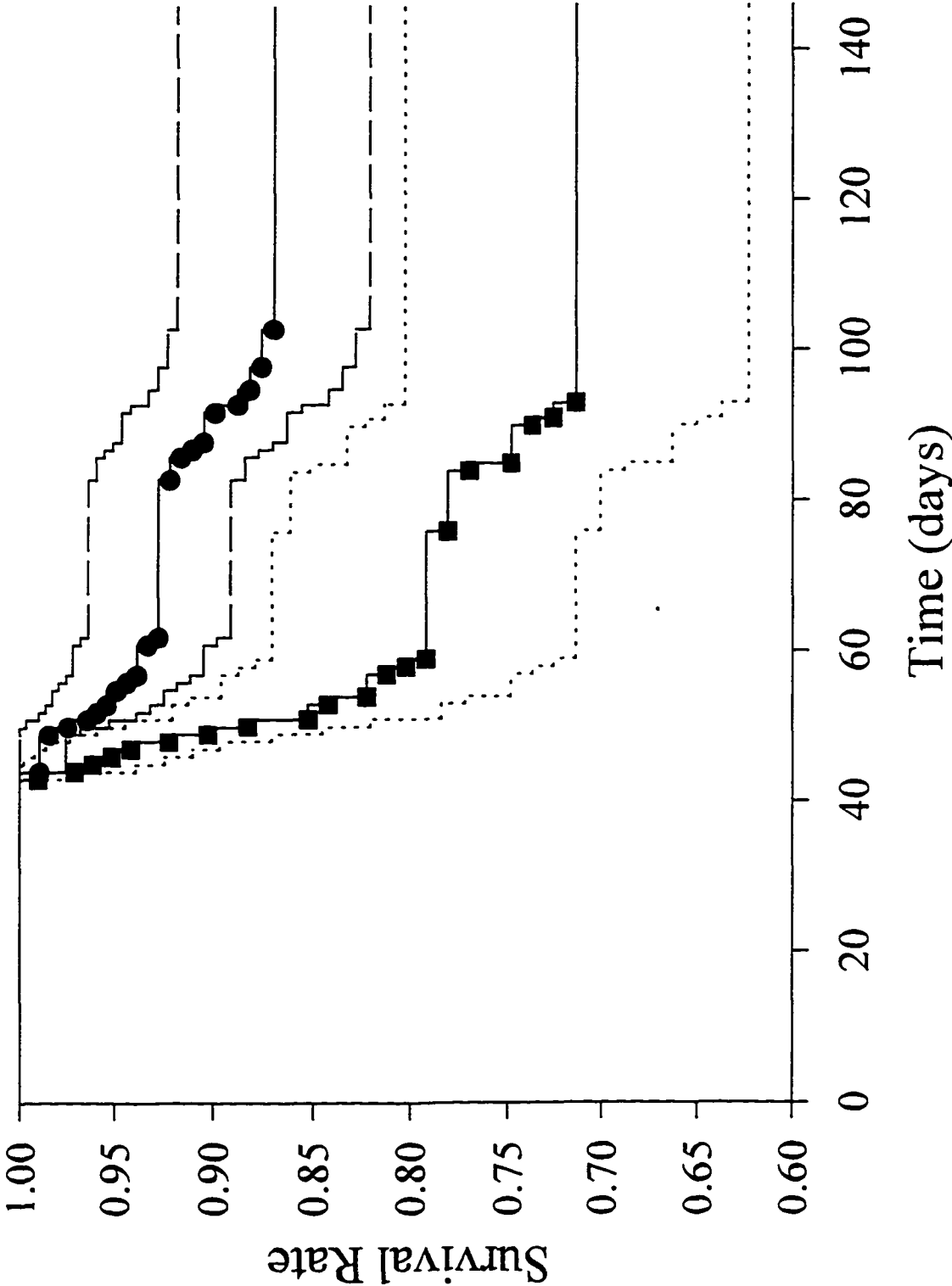


Figure 7.3. Survival rate (5 Oct-28 Feb = 146 days) of radio-tagged female northern pintails (adults = circles; immatures = squares) throughout the Texas-Louisiana Gulf Coast and Mississippi Alluvial Valley during winters 1990-91 through 1992-93, considering hunting mortality only. Dashed and dotted lines are 95% confidence intervals for adults and immatures, respectively.



## DISCUSSION

My overall winter survival estimates for female pintails in southwestern Louisiana were low compared to most other telemetry-based estimates for female dabbling ducks (Table 7.2), but the long time interval (146 days) over which my estimates were calculated should be considered when comparing to other studies. Hunting and non-hunting mortality rates for female pintails in southwestern Louisiana were markedly higher (and corresponding overall survival rates were lower) than those for female pintails in other regions (Table 7.2). In absolute terms, my survival estimates were similar to 59- and 76-day estimates for female American black ducks (*Anas rubripes*) in New Jersey and Virginia and in Maine and New Brunswick, respectively (Table 7.2). Hunting and non-hunting mortality rates of adult female pintails in southwestern Louisiana also were similar to those reported for American black ducks (Table 7.2). Overall survival rates of pintails in southwestern Louisiana were lower than those for mallards (*Anas platyrhynchos*) elsewhere, although my confidence intervals for adult females overlap with those of mallards in Texas (Table 7.2). Estimated hunting mortality of adult female pintails in southwestern Louisiana (16.5%) was as high as that of American black ducks in New Jersey and Virginia, which previously were the highest reported for adult female dabbling ducks. Estimated hunting mortality for immature female pintails in southwestern Louisiana (31.5%) is considerably higher than the next highest estimate for immature female dabbling ducks (19% for mallards; Reinecke et al. 1987; Table 7.2).

Table 7.2. Estimated survival, hunting mortality, and non-hunting mortality rates of wintering female dabbling ducks using harness-type radio transmitters (Dwyer 1972).

Species	Region	Days	Age	Survival Rate $\bar{x}$	SE	Hunting Mortality Rate	Non-hunting Mortality Rate	Reference
northern pintail	MX	107	Ad, Imm	0.911		0.048-0.103	0-0.019	Migoya and Baldassarre 1995
northern pintail	CA	180	Ad	0.874	0.030	0.041-0.087	0.013-0.076	Miller et al. 1995
northern pintail	LA	146	Ad	0.714	0.045	0.165	0.145	This study
			Imm	0.550	0.068	0.315	0.196	
mallard	MS-AR	70	Ad	0.840		0.120	0.040	Reinecke et al. 1987
			Imm	0.700		0.190	0.011	
mallard	TX	100	Ad, Imm	0.777	0.040	0.018	0.210	Bergan and Smith 1993
mallard	AR	30	Ad, Imm	0.993	0.014		0.007	Dugger et al. 1994
Am. black duck	NJ, VA	59	Ad	0.729	0.058	0.149	0.143	Conroy et al. 1989
			Imm	0.599	0.048	0.165	0.282	
Am. black duck	ME-NB	76	Imm	0.593	0.060		0.306	Longcore et al. 1991

Not only was hunting mortality of female pintails in southwestern Louisiana greater than that of female pintails elsewhere, but the pattern of hunting mortality also differed from that observed in other studies. Hunting mortality of female pintails in Sinaloa, Mexico was highest when the hunting season began (Migoya and Baldassarre 1995). In contrast, hunting mortality of radio-tagged adult female pintails in the Sacramento Valley of California occurred late in the continuous 79-day hunting season during 1987-88, and only during the second hunting seasons of 1988-89 and 1989-90 (Miller et al. 1995). In my study, hunting mortality of female pintails was high throughout first and second hunting seasons. This finding is consistent with my observations and interviews with hunters who shot radio-tagged pintails (Cox, unpubl. data) that hunter effort in southwestern Louisiana was consistently high throughout hunting seasons.

Miller et al. (1995) speculated that hunting mortality of adult females in the Sacramento Valley of California was low in part because females reacquainted themselves with refuges during the nearly 2 months between arrival and beginning of hunting seasons. Pintails arriving closer to the start of, or during, hunting season were suggested to be at greater risk from hunting and natural mortality (Miller et al. 1995). Large numbers of pintails did not arrive in southwestern Louisiana until mid- to late October, and most of my radio-tagged females were captured in late October, only 3 weeks before first hunting seasons began in mid-November. Further, pintails in California established routines of roosting diurnally on refuges and nocturnal feeding in agricultural areas before the start of hunting (Miller 1985). In contrast, diurnal use of

non-refuge areas (67%) by female pintails in southwestern Louisiana was twice as high as that of refuges (33%) prior to hunting seasons (Chapter 4). Thus, greater familiarity with and use of refuges prior to hunting season may partly explain lower mortality rates of pintails in California compared to southwestern Louisiana.

Pintails in large concentrations on Lacassine National Wildlife Refuge, the primary diurnal roost of females during my study, spend virtually no time feeding (Tamisier 1976), suggesting that food resources are limited. In contrast, pintails on National Wildlife Refuges in the Sacramento Valley typically feed >10% of daylight hours (Miller 1985). Thus, greater food availability on diurnal roosts also may contribute to greater survival of adult female pintails in California.

I found no effects of body condition at capture on survivorship. This held true when I tested for condition effects simultaneously with other covariates and when I tested for condition effects alone. Similarly, survival of adult and immature female pintails in Mexico was not related to body condition (Migoya and Baldassarre 1995), and survival of adult female pintails in California was not related to body mass (Miller et al. 1995). However, relatively low mortality rates in other studies resulted in lower power for testing for condition effects. Body mass and condition of pintails can change rapidly after arrival on wintering areas (Miller 1986), but tests of condition effects on female pintail survival have relied on a single measure of condition taken at the time of capture, soon after pintails arrive on wintering areas (Migoya and Baldassarre 1995, Miller et al. 1995, this study). Thus, I am reluctant to conclude that survival of pintails in

southwestern Louisiana is not related to condition because condition of females upon arrival may not accurately reflect their condition status later in winters.

I found that immature female pintails in southwestern Louisiana survived at lower rates than did adults, primarily because hunting mortality of immatures was greater. Lower annual survival rates of immatures than adults is commonly reported in banding and mark-resighting studies of dabbling ducks (Johnson et al. 1992, Arnold and Clark 1996). My findings also are consistent with conclusions by Johnson et al. (1992) that large age-specific differences in survival rates of mallards occur primarily between August and February, which includes fall migration and hunting periods. Immature females were in poorer condition than adults, but survival did not differ in relation to condition. I detected no difference in use of habitats between age classes of female pintails in southwestern Louisiana (Chapter 4). In total, these findings suggest that immatures were more vulnerable to hunting because they were more naive (i.e., less wary) to hunting than adults, and not because they were in poorer condition or because they used habitats differently.

I found no evidence of differential hunting mortality of females within versus outside of my primary study area. However, power for testing region effects was relatively low because 76% of female pintail exposure days prior to 20 January (latest possible date for hunting seasons) occurred inside my primary study area. Thus, my estimates of hunting mortality including both regions are more representative of southwestern Louisiana than the remainder of the Texas-Louisiana Gulf Coast and Mississippi Alluvial Valley.



Annual survival rates of adult female pintails throughout the Gulf Coasts of Louisiana and Texas, estimated from winter bandings, were 67 and 70% during 1964-1966 and 1976-1978, respectively (Hestbeck 1993b), which is only slightly lower than my 146-day estimate for adult females in southwestern Louisiana. Assuming that annual survival rates during my study were similar, survival rates during March-September (219 days) would be 94-98%. These estimates seem unrealistically high given substantial mortality of female dabbling ducks on breeding areas (e.g., Johnson and Sargeant 1977). Thus, the apparent discrepancy between annual survival estimates for adult female pintails of Hestbeck (1993b) and those based on my estimates of winter survival may be due to: (1) temporal decline in annual survival rates from the 1960s and 1970s to the early 1990s, (2) marked heterogeneity of winter survival rates among regions within the Mississippi Alluvial Valley and Gulf Coast regions, or (3) under-estimated winter survival rates in my study, possibly due to radio effects. Further investigations of these relationships are needed.

## **MANAGEMENT IMPLICATIONS**

High hunting and non-hunting mortality of female pintails, particularly immatures, that I observed indicates that southwestern Louisiana is an area of concern. I see little potential for management of non-hunting mortality factors (primarily predation) of female pintails in this region. Legal hunting, the most manageable winter mortality factor in my study, accounted for the majority of total mortality of both age classes of female pintails in southwestern Louisiana. However, high hunting mortality, particularly of immatures, occurred under conservative regulations (30-day season and 1 pintail

daily). It is not possible to further restrict pintail bag limits short of closing the season. Further, I saw no evidence that high hunting mortality was followed by compensatory reductions in non-hunting mortality following hunting seasons on this wintering area (mean survival rate during POST was lower, but did not differ statistically, from that during PRE and SPLIT).

If food resources are limited on major diurnal concentration areas in southwestern Louisiana (Tamisier 1976, Chapter 3, Chapter 4), I believe that increasing the availability of foods on these areas may decrease hunting mortality rates of female pintails in this region. Further, I believe that high hunting mortality of female pintails reflects a deep tradition of pintail hunting in southwestern Louisiana. As a result of this tradition, I believe that hunter effort, hunter knowledge of pintail movements and habits, hunter preference for pintails as table fare, and skill levels (identification, calling, shooting, etc.) of hunters are high. Many of the dedicated hunters with whom I talked had adopted a strategy of shooting a limit of ducks as soon as possible after legal hours began in the mornings. These hunters believed that leaving hunting areas (largely agricultural fields) undisturbed for the majority of the day allowed them to successfully hunt the same field or blind regularly (often daily) throughout the season. I believe that this practice may have encouraged indiscriminant shooting of pintails with regard to sex. Thus, I believe that there is potential for shifting at least some of the hunting mortality of females to males through hunter-education, incentives, or mandating in regulations. However, winter survival rates of male pintails in southwestern Louisiana are not known, and should be estimated prior to and after adopting such programs.

## LITERATURE CITED

- Alisauskas, R. T., and C. D. Ankney. 1987. Age-related variation in the nutrient reserves of breeding American coots (Fulica americana). *Can. J. Zool.* 65:2417-2420.
- Ankney, C. D., and A. D. Afton. 1988. Bioenergetics of breeding northern shovelers: diet, nutrient reserves, clutch size, and incubation. *Condor* 90:459-472.
- Arnold, T. W., and R. G. Clark. 1996. Survival and philopatry of female dabbling ducks in southcentral Saskatchewan. *J. Wildl. Manage.* 60:560-568.
- Bergan, J. F., and L. M. Smith. 1993. Survival rates of female mallards wintering in the Playa Lakes region. *J. Wildl. Manage.* 57:570-577.
- Carney, S. M. 1964. Preliminary keys to waterfowl age and sex identification by means of wing plumage. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Wildl. 82. 47pp.
- Conroy, M. J., G. R. Costanzo, and D. B. Stotts. 1989. Winter survival of female American black ducks on the Atlantic Coast. *J. Wildl. Manage.* 53:99-109.
- Cox, D. R. 1972. Regression models and life-tables (with discussion). *J. R. Stat. Soc. Ser. B* 34:187-220.
- Cox, R. R., Jr., and A. D. Afton. 1994. Portable platforms for setting rocket nets in open-water habitats. *J. Field Ornithol.* 65:551-555.
- Dugger, B. D., K. J. Reinecke, and L. H. Fredrickson. 1994. Late-winter survival of female mallards in Arkansas. *J. Wildl. Manage.* 58:94-99.
- Duncan, D. C. 1985. Differentiating yearling from adult northern pintails by wing-feather characteristics. *J. Wildl. Manage.* 49:576-579.
- Dwyer, T. J. 1972. An adjustable radio-package for ducks. *Bird-Banding* 43:282-284.
- Dzubin, A., and E. G. Cooch. 1992. Measurements of geese: general field methods. California Waterfowl Assoc., Sacramento. 20pp.
- Gilmer, D. S., L. M. Cowardin, R. L. Duval, L. M. Mechlin, C. W. Shaiffer, and V. B. Kuechle. 1981. Procedures for the use of aircraft in wildlife biotelemetry studies. U. S. Fish and Wildl. Serv. Resour. Publ. 140. 19pp.

- Hestbeck, J. B. 1993a. Overwinter distribution of northern pintail populations in North America. *J. Wildl. Manage.* 57:582-589.
- , 1993b. Survival of northern pintails banded during winter in North America, 1950-88. *J. Wildl. Manage.* 57:590-597.
- Hochbaum, H. A. 1942. Sex and age determination of waterfowl by cloacal examination. *Trans. N. Am. Wildl. Conf.* 7:299-307.
- Howard, R. J., and H. A. Kantrud. 1986. Habitat suitability models: northern pintail (Gulf Coast wintering). *U. S. Fish and Wildl. Serv. Biol. Rep.* 82(10.121). 16pp.
- Johnson, D. H., and A. B. Sargeant. 1977. Impact of red fox predation on the sex ratio of prairie mallards. *U.S. Fish Wildl. Serv. Wildl. Res. Rep.* 6. 56pp.
- , J. D. Nichols, and M. D. Schwartz. 1992. Population dynamics of breeding waterfowl. Pages 446-485 in B. D. J. Batt, A. D. Afton, M. G. Anderson, C. D. Ankney, D. H. Johnson, J. A. Kadlec, and G. L. Krapu, eds. *Ecology and management of breeding waterfowl*. Univ. Minnesota Press, Minneapolis.
- Longcore, J. R., D. G. McAuley, and C. Frazer. 1991. Survival of postfledging female American black ducks. *J. Wildl. Manage.* 55:573-580.
- Migoya, R., and G. A. Baldassarre. 1995. Winter survival of female northern pintails in Sinaloa, Mexico. *J. Wildl. Manage.* 59:16-22.
- Miller, M. R. 1985. Time budgets of northern pintails wintering in the Sacramento Valley, California. *Wildfowl* 36:53-64.
- , 1986. Northern pintail body condition during wet and dry winters in the Sacramento Valley, California. *J. Wildl. Manage.* 50:189-198.
- , J. P. Fleskes, D. L. Orthmeyer, W. E. Newton, and D. S. Gilmer. 1995. Survival of adult female northern pintails in Sacramento Valley, California. *J. Wildl. Manage.* 59:478-486.
- Reinecke, K. J., C. W. Shaiffer, and D. Delnicki. 1987. Winter survival of female mallards in the lower Mississippi Valley. *Trans. N. Am. Wildl. Nat. Resour. Conf.* 52:258-263.
- SAS Inst. Inc. 1989. *SAS/STAT User's Guide, Version 6, Fourth ed.* SAS Inst. Inc. Cary, NC. 846pp.

- 1996. SAS/STAT software: changes and enhancements through release 6.11. SAS Inst. Inc., Cary, NC. 1080pp.
- Tamisier, A. 1976. Diurnal activities of green-winged teal and pintail wintering in Louisiana. *Wildfowl* 27:19-32.
- U. S. Fish and Wildlife Service and Canadian Wildlife Service. 1986. North American waterfowl management plan. Washington, D.C. 31pp.
- 1996. Waterfowl population status, 1996. *Off. Migr. Bird Manage.*, Laurel, Md. 28pp.

## **Chapter 8**

### **Conclusion**

My study has provided answers to several critical questions concerning management of pintails wintering in southwestern Louisiana, namely: (1) How far do pintails leaving Lacassine National Wildlife Refuge (NWR) travel on evening flights, and how long does it take them to reach their destinations? (2) What habitats are important to pintails, particularly at night? (3) Does hunting affect habitat use by pintails, and if so, how? (4) How do mini-refuges compare to large permanent pools with respect to use by pintails? (5) What is the survival rate of pintails while wintering in this region, and how does mortality due to hunting compare to natural mortality? My results clearly indicate that pintails rely on refuges (primarily Lacassine Pool and to a lesser extent, Amoco Pool) to escape high hunting pressure (Chapter 4, Chapter 5). Use of Amoco Pool probably was lower during my study than in most winters (Tamisier 1976, R. N. Helm, pers. comm), which I attribute to decreased food availability caused by prolonged flooding during the 1991 growing season (Chapter 5). Little diurnal feeding by pintails on Lacassine NWR (Tamisier 1976) suggests that pintails roosting diurnally on pools in this region obtain much, if not most, of their food at night. Thus, my results indicate that pintails obtain most foods at night from privately owned fallow and rice fields that are hunted during the day (Chapter 4). I found that pintails regularly travel long distances from diurnal refuges to obtain food at night (Chapter 3), which indicates that benefits of using refuges are great. High hunting mortality (Chapter 7) suggests that increased survival is a primary benefit of using refuges. Several of my results indicate that food

resources on refuges in southwestern Louisiana are limited: (1) flight distance and duration increased over time during winters (Chapter 3), (2) diurnal use of refuges within hunting and non-hunting periods decreased over time during winters (Chapter 4), (3) nocturnal use of refuges decreased over time during winters (Chapter 4), and (4) hunting mortality rates of adult and immature females were as high or higher than previously reported estimates for wintering female dabbling ducks using identical radio-telemetry techniques (Chapter 7). If foods on refuges indeed are limited in this region, increasing availability of agricultural and moist-soil foods on these areas could reduce substantially daily energy expenditure for flight and hunting mortality rates.

Several important questions regarding wintering ecology of pintails in this region remain unanswered. Studies of diel food habits, diel time-activity budgets, and nutrient-reserve dynamics should be fruitful areas for future research. Foraging ecology and time activity budgets should be examined in refuge and non-refuge areas, and in ephemeral habitats created by frequent and heavy rains.

#### **LITERATURE CITED**

- Tamisier, A. 1976. Diurnal activities of green-winged teal and pintail wintering in Louisiana. *Wildfowl* 27:19-32.

## Appendix

24 June 1996

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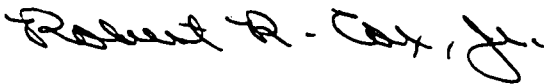
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## THE CONDOR

PUBLISHED BY THE COOPER ORNITHOLOGICAL SOCIETY

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## **Vita**

Robert Ripley Cox, Jr., the only son of Robert Ripley Cox, Sr. and Dorothy Shiver Cox, was born 1 March 1959 in Moultrie, Georgia. He graduated from Pineland High School in Moultrie, Georgia, in 1977. He married Regina Kim Medley in 1982. He earned his Associate of Arts degree in general education from Thomas County Community College in Thomasville, Georgia, in 1983, and his Bachelor of Science degree in Forest Resources (wildlife concentration) from the University of Georgia in 1987. He received a Lane Fellowship to the Delta Waterfowl and Wetlands Research Station in 1988, and began work on his Master of Science degree in Fisheries and Wildlife at Utah State University later that year. He received an Alumni Federation Fellowship from Louisiana State University and began work on his Doctor of Philosophy degree in 1990. He completed his Master of Science degree in 1993. He and his wife have 2 sons, Joshua Fredrick and Matthew James. He and his family presently live in Jamestown, North Dakota, where he is employed as a waterfowl ecologist at Northern Prairie Science Center of the National Biological Service.


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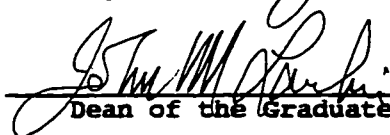
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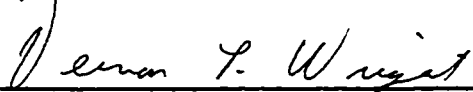
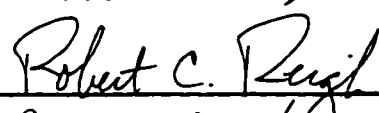

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