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Factors Affecting Body Condition of Northern Pintails Wintering in the Playa Lakes Region

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Abstract.—We assessed the effects of capture period, capture subregion, age, sex and habitat conditions on the body condition of migrating and wintering Northern Pintails (*Anas acuta*) in the Playa Lakes Region (PLR) of northwestern Texas. Body condition varied with sex, age, subregion and month during the wet 2002. During 2002, after-hatch-year (AHY) males had more carcass fat (g and percent) than did AHY females. Likewise, AHY males had 34% more carcass fat (g) than hatch-year (HY) males, but we did not detect differences between AHY and HY females. The average increase in carcass fat (g) from October to November-December during wet 2002, was 26% for males and 42 to 93% (HY) for females. Body condition of pintails in the south exceeded those captured in northern subregions of the PLR during wet 2002, but not dry 2003. Southern caught AHY males had 31% more carcass fat (g) than northern caught AHY males, but we found no differences for HY males. Females caught in southern subregions also had 24-77% more carcass fat (g) than northern captured females. During dry 2003, pintail carcass fat (g and %) did not vary by capture location or among age and sex classes, except for males, which increased carcass fat by 34% between capture periods. From our findings, we recommend that managers periodically assess pintail body condition to detect temporal trends of condition status and measure population response to conservation efforts. However, use of body condition measures to evaluate habitat management and conservation efforts must be evaluated in the context of habitat conditions, sample locations, period of sample collection and age and sex classes.
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Key words.—*Anas acuta*, body condition, Northern Pintail, Playa Lakes Region.

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The North American population of Northern Pintails (*Anas acuta*) has declined since the late 1970s and remains well below the goal of 5.6 million set by the North American Waterfowl Management Plan (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1998; Miller and Duncan 1999). This decline is thought to be primarily the result of low nest success and poor breeding propensity leading to declining recruitment, as well as disease and decreasing annual survival rates (Austin and Miller 1995; Miller and Duncan 1999). However, body condition during winter may also be an important factor in the decline of the pintail population, especially during dry winters (Raveling and Heitmeyer 1989). In the Playa Lakes Region (PLR) of northwestern Texas, carcass fat of pintails during October has declined 23% and 33% for males and females, respectively, between 1984-1985 and 2002-2003, possibly due to declines in overall habitat conditions within the PLR and Central Flyway (Moon *et al.* 2007).

Avian body condition is a measure of carcass fat or other endogenous reserves relating to the nutrient status of an individual or population (Reinecke *et al.* 1986). The best measure of body condition of wintering waterfowl is a complete assessment of fat reserves (Johnson *et al.* 1985; Ringelman and Szymczak 1985). Unfortunately, direct measurement of carcass fat requires collection, dissection, and analysis of sacrificed individuals (Bailey 1979; Chappell and Titman 1983; Whyte and Bolen 1984). Condition models that adjust body mass with structural measurements to estimate carcass fat have been developed for several waterfowl species, including pintails (Owen and Cook 1977; Bailey 1979; Wishart 1979; Ringelman and Szymczak 1985; Miller 1989; Smith *et al.* 1992; Haukos *et al.* 2001; DeVault *et al.* 2003). However, use of these models is often limited to the geographic region and season in which they were developed. Use of such models may provide valuable information on the impacts of habitat management on waterfowl populations, especially in the PLR.

Assessing the body condition of migrating and wintering waterfowl may help investigators (1) predict future survival, (2) evaluate effects of body condition on behavior (e.g., courtship activities) and habitat use, and (3) monitor population responses to habitat management (Heitmeyer and Fredrickson 1981; Miller 1986; Smith and Sheeley 1993; Moon and Haukos 2006). However, the reliability of using body condition as a measure of the health of wintering waterfowl populations has been questioned because of the unknown influence of intrinsic (e.g., age and sex) and extrinsic (e.g., location, month and habitat conditions) factors on condition (Reinecke *et al.* 1986).

The PLR, containing the Southern High Plains (SHP), provides important migrating and wintering habitat for several million waterfowl each year (Bellrose 1980; Fedynich *et al.* 1989). Historically, at least one third of the pintails wintering in the Central Flyway used the PLR, with numbers at times being >300,000 (Bellrose 1980). Concurrent with the continental population decline, there has been an estimated 47% decline in midwinter pintail numbers in the PLR since the late 1970s (Haukos 2003). This decline likely reflects the overall decline of the pintail population, perhaps facilitated by degradation of habitats in the region. Conservation and improved management of playa wetlands have been proposed as ways to increase pintail populations in the PLR (Haukos and Smith 2003; Moon and Haukos 2006). Monitoring the body condition of pintails could be used as one measure of the effectiveness of proposed playa management strategies, but knowledge of the factors that influence body condition of pintails in the PLR is needed for proper interpretation of such data.

Timing and amount of annual precipitation determines the quantity and quality of playa wetlands available to migrating and wintering waterfowl (Haukos and Smith 1993; Smith and Sheeley 1993). Previous estimates of body condition in the PLR during the mid-1980s correlated body condition of wintering pintails to season (e.g., early, mid, and late winter) and amount of annual precipitation (a surrogate for available habitat; Smith and Sheeley 1993). However, the general decline in body condition of pintails wintering in the PLR requires re-evaluation of these factors under current habitat conditions (Moon 2004; Moon *et al.* 2007). The objectives of our study were to estimate carcass fat mass (g) and percent carcass fat in Northern Pintails wintering in the PLR and assess the response of these indices of body condition to 1) time period, 2) capture location, 3) age and 4) sex. Based on these findings, we provide recommendations for the use of body condition to monitor pintail populations wintering in the PLR.

STUDY AREA AND METHODS

The PLR of northwest Texas consists of the High Plains (north of the Canadian River), the SHP and part of the eastern adjacent Rolling Plains ecological region (Haukos and Smith 1994; Moon 2004). We concentrated our study in the SHP that encompassed 130,000 km^2 and contained approximately 20,000 playa wetlands (Haukos and Smith 1994). The SHP has a dry steppe climate with mild winters (Blackstock 1979), a growing season of 180-220 days (Gould 1975) and an average annual precipitation of 50 cm (National Climatic Data Center 2004). Most precipitation occurs as rain from May-September (Bolen *et al.* 1989). Elevations in the SHP ranged from 1000-1200 m (Haukos and Smith 1994), with nearly level to gently undulating topography interrupted by numerous enclosed depressions lined by a hydric vertisol clay, which defines playa wetlands (Blackstock 1979).

During 2002, precipitation in our study area averaged 49 cm, more than twice the 22 cm recorded during 2003 (National Climatic Data Center 2004). About 22% of playas contained enough water for use by ducks during the winter of 2002-2003 (Midwinter Waterfowl Inventory, January 1-5; W. Johnson, Texas Parks and Wildlife Department, personal communication). During 2003-2004, however, <1% of playa wetlands contained water during the Midwinter Inventory (January 2-6; W. Johnson, Texas Parks and Wildlife Department, personal communication).

We captured pintails using baited swim-in traps and rocket nets during 2002 and 2003 (Moon 2004; Moon *et al.* 2007). Because impacts of habitat quality on foraging activities should be most apparent shortly after arrival in the PLR, we captured pintails prior to mid-December and assumed foods would be limited thereafter (Baldassarre and Bolen 1984; Moon 2004). We established two capture periods during each year, October and November through early December, which correspond to the autumn and early winter periods established by Whyte *et al.* (1986) for the region. Specifically, we captured pintails during 10-31 October and 14-28 November in 2002, and 10-31 October and 1 November-2 December in 2003.

We divided the study area into north and south subregions by drawing a line east and west of Tulia, Texas (34°32'N, 101°46'W), that roughly divided the predominant land uses in the region - row cropping to the south and cattle grazing to the north (Moon 2004). During 2002, pintails in the south subregion were captured at two privately-owned playa wetlands in Lubbock County, Texas, whereas pintails in the north subregion were located at moist-soil units (16 ha) at Buffalo Lake National Wildlife Refuge, Randall county, Texas, and two privately-owned playa wetlands in Armstrong and Oldham counties, Texas, During 2003, study areas included three playa wetlands in Randall and Armstrong counties, Texas, in the north subregion and three playas in Lamb County, Texas, in the south region.

We aged and sexed pintails based on plumage characteristics (Duncan 1985, Carney 1992), and measured flattened wing chord (mm) and body mass (±5 g). We qualitatively evaluated each bird for wetness (dry to wet) and fullness of the esophagus (empty to full). Most captured individuals had empty esophagi (73%) and were dry (77%), so we made no adjustments for excess mass. We released birds at the sites of capture after processing.

We estimated carcass fat (g) of each trapped pintail using the "Model 3" equations derived by Smith *et al.* (1992), where they regressed log of carcass fat on log of mass and log of wing chord. These equations explained a relatively large percentage of variation in log of carcass fat in pintails wintering in the PLR, with R^2 values of 0.73, 0.69, 0.72, and 0.75 for adult males, adult females, juvenile males and juvenile females, respectively. Predictive equations overestimated log of fat by only about 2.4% in a validation data set (Smith *et al.* 1992). We converted all log values into grams of fat for presentation purposes. In addition, we calculated percent carcass fat for each bird using the formula [carcass fat (g)/mass (g)]*100. Both grams of fat and percent fat were included in analyses to compare absolute and relative values (i.e., body-size adjusted). We then compared the body condition variables of carcass fat (g and %) among the independent variables of year, sex, age, capture subregion (north or south) and period of capture. Because of correlation between the two dependent variables (r = 0.99, P < 0.0001 in 2002, and r = 0.98, P < 0.0001 in 2003), we initially used factorial multivariate analysis of variance (MANOVA) to compare carcass fat (g and %) between the independent variables using Wilks' lambda as a test statistic (α = 0.05). Following a significant MANOVA result, a factorial analysis of variance (ANOVA) was used to compare each dependent variable between independent variables (PROC GLM, SAS Institute 1997; Analytical Software 2000). Values are presented as mean ± 1 SE.

RESULTS

Age and Sex

We captured 426 Northern Pintails in 2002 (347 in October and 79 during November-December) and 442 in 2003 (290 in October and 152 during November-December). Because we found an age*sex*year interaction (Wilks' lambda = 0.96, P < 0.001), we conducted further analyses by year for age and sex. For 2002, we found an age*sex interaction (Tables 1, 2 and 3) for carcass fat (g) and percent carcass fat, necessitating further analyses comparing age by sex. After-hatch-year (AHY) males had 34% more grams of carcass fat than hatch year (HY) males, and also had higher percent carcass fat than HY males (Tables 1, 2 and 3). For females, we found no differences by age for carcass fat g or percent carcass fat (Tables 2 and 3). We found that AHY males had more grams of carcass fat than AHY females (Tables 1 and 3). However, carcass fat grams did not differ between HY males and HY females (Tables 1 and 3). Percent carcass fat differed between AHY males and AHY females, also between HY males and HY females (Tables 2 and 3). For 2003, we found no age*sex interaction or age effect for carcass fat grams ($\overline{x}$ = 128.7, SE = 3.4) or percent carcass fat ($\overline{x}$ = 14.04, SE = 0.29), however the difference in carcass fat (g) of males and female approached significance (Tables 1, 2 and 3).

Capture Period

We found an age*capture period*year interaction (Wilks' lambda = 0.98, P < 0.001), so we conducted further analyses by year. There was an age*sex*capture period interaction (Wilks' lambda = 0.97, P = 0.041) for 2002, so we conducted further analyses by sex. Male body condition differed between capture periods (Wilks' lambda = 0.94, P = 0.022), with an increase in carcass fat grams of 26% between October and November-December (early = 151.4 ± 5.0 g; late = 189.9 ± 13.0 g; Table 1). We found an age*capture period interaction for percent carcass fat (Table 2). For AHY males, percent carcass fat did not differ between capture periods (Tables 2, 3 and 4). For HY males, however, percent carcass fat was lower in October than November-December (Tables 2, 3 and 4).

For females, we found an age*capture period interaction (Wilks' lambda = 0.89, P = 0.006) during 2002 and, therefore, compared body condition between capture periods for HY and AHY females. Carcass fat grams for AHY females and HY females varied with capture period (Tables 1 and 5). We

Table 1. Univariate analysis of variance testing the influence of demographics (age and sex), capture period and capture subregion following the results of interaction tests on estimated body fat (grams) of Northern Pintails captured in the Playa Lakes Region of northwestern Texas, 2002-2003.

Variable	Year		F	df	P
Age and Sex[a]	2002	Age*Sex	7.99	7,873	0.005
		Age M	42.30	1,260	≤0.001
		Age F	2.60	1,162	0.110
		Sex AHY	16.97	1,259	≤0.001
		Sex HY	5.60	1,165	0.590
	2003	Age*Sex	0.30	3,451	0.58
		Age	1.22	3,451	0.27
		Sex	3.68	3,451	0.064
Capture Period[b]	2002	M	14.01	1,258	0.002
		F AHY	26.5	1,85	≤0.001
		F HY	63.5	1,75	≤0.001
	2003	M	9.9	1,281	0.002
		F	0.5	1,168	0.50
Subregion[c]	2002	M AHY	8.7	1,171	0.004
		M HY	0.2	1,87	0.70
		F AHY	8.3	1,85	0.005
		F HY	23.6	1,75	≤0.001

[a]Adult male (M AHY), adult female (F AHY), juvenile male (M HY) and juvenile female (F HY).

[b]During 2002 (wet year) approximately 22% of playa wetlands were available to wintering waterfowl, and during 2003 (dry year) less than 1% of playa wetlands were available to wintering waterfowl.

[c]Pintails were captured during two different capture periods 10-31 October and 14-28 November in 2002, and 10-31 October and 1 November-2 December in 2003.

[d]Two subregions were tested: north - areas north of Tulia, Texas (34°32'N, 101°46'W), and south—areas south of Tulia Texas.

[e]Northern trapping areas consisted mainly of native grasslands and grazing pastures, while southern trapping areas were dominated by row cropping (mainly cotton and grains).

found that AHY females had 42% less carcass fat in October than in November-December (Table 5). Hatch-year females captured in October had 93% less carcass fat than those captured in November-December (Table 5). Percent carcass fat of AHY females and HY females also differed with capture period (Tables 2 and 5). AHY females captured during October had 24% less percent carcass fat than November-December captured AHY females, and HY females captured during October had 67% less percent carcass fat than those captured in November-December (Table 5). During the late capture period, both grams of carcass fat and percent carcass fat were similar between ages for females.

During 2003, we detected a sex*capture period interaction (Wilks' lambda = 0.98, P = 0.038); therefore, we conducted further analyses by sex comparing capture periods. For males, November-December captured males had 34% more carcass fat when compared with those captured in October (Tables 1 and 6). However, percent carcass fat did not differ by capture period (Tables 2 and 6). Female pintails had similar levels of carcass fat grams (Table 1) and percent carcass fat between October and November-December during 2003 (Tables 2 and 6).

Capture Subregion

We found a capture subregion*year interaction (Wilks' lambda = 0.98, $P < 0.001$) and detected a sex*age interaction (Wilks' lambda = 0.96, P = 0.022) during 2002. Therefore, we conducted subsequent analyses to compare capture subregions by sex. For males, we detected an age*subregion interaction (Wilks' lambda = 0.94, P = 0.02); therefore, we compared male capture data between subregions for each age class. During 2002, AHY male pintails had less carcass fat (g) in the north capture subregion than the south subregion, but HY male carcass fat grams did not differ between capture subre-

Table 2. Univariate analysis of variance testing the influence of demographics (age and sex), capture period and capture subregion following results of interaction tests on estimated percent body fat of Northern Pintails captured in the Playa Lakes Region of northwestern Texas, 2002-2003.

Variable	Year		F	df	P
Age and Sex[a]	2002[b]	Age*Sex	7.99	7,873	0.005
		Age M	44.01	1,260	≤0.001
		Age F	1.34	1,162	0.250
		Sex AHY	21.60	1,259	≤0.001
		Sex HY	17.90	1,165	0.003
	2003	Age*Sex	0.30	3,451	0.58
		Age	1.22	3,451	0.27
		Sex	3.68	3,451	0.064
Capture Period[c]	2002	Age*Period	4.8	1,258	0.036
		M AHY	2.78	1,171	0.10
		M HY	11.2	1,87	≤0.001
		F AHY	28.6	1,85	≤0.001
		F HY	62.6	1,75	≤0.001
	2003	M	10.1	1,281	0.21
		F	0.8	1,168	0.36
Subregion[d,e]	2002	M AHY	8.9	1,171	0.003
		M HY	0.2	1,87	0.7
		F AHY	10.7	1,85	0.002
		F HY	25.9	1,75	≤0.001

[a]Adult male (M AHY), adult female (F AHY), juvenile male (M HY), and juvenile female (F HY).

[b]During 2002 (wet year) approximately 22% of playa wetlands were available to wintering waterfowl, and during 2003 (dry year) less than 1% of playa wetlands were available to wintering waterfowl.

[c] Pintails were captured during two different capture periods 10-31 October and 14-28 November in 2002, and 10-31 October and 1 November-2 December in 2003.

[d]Two subregions were tested: north - areas north of Tulia, Texas (34°32'N, 101°46'W), and south—areas south of Tulia Texas.

[e]Northern trapping areas consisted mainly of native grasslands and grazing pastures, while southern trapping areas were dominated by row cropping (mainly cotton and grains).

gions (Tables 1 and 7). Similarly, AHY male percent carcass fat was lower in the northern subregion than the southern capture subregion, but HY male percent carcass fat did not differ (Tables 2 and 7).

For females, carcass fat (g) and percent carcass fat differences between capture subregions depended on age (Wilks' lambda = 0.69, $P < 0.001$). During 2002, AHY and HY females captured in the southern trapping subregion had 24% and 77% more grams of carcass fat than did AHY and HY females captured in the northern trapping areas (Tables 1 and 7). Also, AHY and HY females captured in the south region had 18% and 36%, respectively, more percent carcass fat than birds trapped in the north subregion trapping area (Tables 2 and 7).

During 2003, we found no capture subregion*sex (Wilks' lambda = 0.99, $P = 0.23$),

Table 3. Average (SE) estimated carcass fat (g and percent) of adult (AHY) and juvenile (HY) male and female Northern Pintails captured in the Playa Lakes Region of Texas during fall 2002.

	Male		Female	
	AHY	HY	AHY	HY
N	173	89	87	77
Carcass fat (g)	176.8Aa* (5.0)	116.7Ab (8.5)	130.5Ba (4.5)	117.8Aa (6.7)
Carcass fat (%)	17.1Aa (0.4)	12.5Ab (0.7)	15.6Ba (0.4)	14.8Ba (0.7)

*Values followed by the same uppercase letter did not differ ($P > 0.05$) between sexes within age, and values followed by the same lowercase letter did not differ ($P > 0.05$) between ages within sex.

Table 4. Average (SE) estimated carcass fat (percent) of adult (AHY) and juvenile (HY) male Northern Pintails captured during two different periods (early - 10 October-23 October; late - 14 November-27 November) in the Playa Lakes Region of Texas during fall 2002.

	AHY		HY	
Body condition	Early	Late	Early	Late
N	153	20	75	14
Carcass fat (%)	16.9A* (0.4)	18.7A (0.9)	11.5A (0.7)	17.6B (2.1)

*Values followed by the same uppercase letter did not differ ($P > 0.05$) between capture periods within age.

Table 5. Average (SE) estimated carcass fat (g and percent) of adult (AHY) and juvenile (HY) female Northern Pintails captured during two different periods (early - 10 October-23 October; late - 14 November-27 November) in the Playa Lakes Region of Texas during fall 2002.

	AHY		HY	
Body condition	Early	Late	Early	Late
N	69	18	50	27
Carcass fat (g)	120.1A* (4.4)	170.3B (8.5)	88.9A (5.7)	171.3B (9.3)
Carcass fat (%)	14.7A (0.4)	19.4B (0.8)	11.9A (0.6)	19.9B (0.8)

*Values followed by the same uppercase letter did not differ (P > 0.05) between capture periods within.

Table 6. Average (SE) estimated carcass fat (g and percent) of adult (AHY) and juvenile (HY) male and female Northern Pintails captured during two different time periods (early: 10 October-31 October; late: 1 November-2 December) in the Playa Lakes Region of Texas in 2003.

	Male		Female	
Body condition	Early	Late	Early	Late
N	172	113	118	39
Carcass fat (g)	117.2A* (4.4)	134.1B (7.4)	131.8A (7.4)	147.8A (11.4)
Carcass fat (%)	13.5A (0.4)	13.6A (0.6)	14.9A (0.7)	14.7A (0.9)

*Values followed by the same uppercase letter did not differ (P > 0.05) between capture periods within sex.

capture subregion*age (Wilks' lambda = 0.99, P = 0.36), or capture subregion*age*sex (Wilks' lambda = 0.99, P = 0.77) interactions. There was a tendency for differences (Wilks' lambda = 0.99, P = 0.07) in body condition between pintails captured in south ($\overline{x}$ = 131.0 g, SE = 4.5; = 14.2%, SE = 0.4) and north ($\overline{x}$ = 125.6 g, SE = 5.3; = 13.9%, SE = 0.5) subregions during 2003.

DISCUSSION

Body condition of wintering Northern Pintails in the PLR primarily reflected habitat conditions (year), and only secondarily age, sex, capture period and subregion effects. During 2002-2003, habitat was relatively good for wintering waterfowl in the PLR (Moon 2004), with above average rainfall in the late spring and summer increasing the number of playa wetlands (Haukos and Smith 1993; Smith and Sheeley 1993). Later, fall rains improved wetland conditions for migrating and wintering waterfowl, and likely increased the availability of invertebrates and seeds in an estimated 4,000 playa wetlands (Anderson and Smith 2000).

Smith and Sheeley (1993) reported that during wet years, when additional playa habitats were available, pintails established pair bonds earlier, initiated field feeding later, and maintained better overall body condition than during years of below-average precipitation. Despite the relationship between body condition and weather-induced habitat conditions, Moon *et al.* (2007) found a long-

Table 7. Average (SE) estimated carcass fat (g and percent) of adult (AHY) and juvenile (HY) male and female Northern Pintails captured at two different sites (north and south) during fall 2002 in the Playa Lakes Region of Texas.

	Male				Female			
	AHY		HY		AHY		HY	
Body condition	North	South	North	South	North	South	North	South
N	12	161	20	69	26	61	26	51
Carcass fat (g)	123.9A* (8.5)	180.8B (5.2)	109.9A (13.8)	118.6A (10.2)	111.1A (6.6)	138.6B (5.2)	77.9A (6.4)	138.1B (8.1)
Carcass fat (%)	13.4A (0.7)	17.4B (0.4)	11.9A (1.2)	12.6A (0.8)	13.6A (0.6)	16.5B (0.5)	10.7A (0.7)	16.8B (0.8)

*Values followed by the same uppercase letter did not differ (P > 0.05) between capture sites within age class for each sex.

term decline in pintail body condition since the mid-1980s. This trend is evident even when average or better habitat conditions occur within the PLR. However, the lack of differences in body condition found among sex and age classes and geographic locations during 2003, which was the driest year in PLR since 1911, indicates that during years of below-average rainfall, the number and quality of playa wetlands was insufficient to support an increase in body condition during average precipitation years (e.g. 2002) or to levels experienced in the 1980s. Pintails captured during 2003 had 8.4-35.1% less carcass fat than those captured during 2002 (mean of 21% less carcass fat overall), which negatively affected over-winter survival (Moon and Haukos 2006).

During both years of our study, pintails captured in November-December generally had greater fat content than those captured in October. This pattern of rapidly increasing body condition of pintails in the PLR has been shown previously (Smith and Sheeley 1993), and is characteristic also for Mallards (*Anas platyrhynchos*; Whyte *et al.* 1986) and American Wigeon (*Anas americana*; Rhodes 1991). Pintails likely acquire these fat reserves by foraging in playa habitats (Smith and Sheeley 1993; Moon 2004), and low fat reserves likely contributed to decreased over-winter survival during years of poor habitat conditions (Moon and Haukos 2006). For all studied species, carcass fat levels declined in the PLR from midwinter through the start of spring migration because ducks catabolize fat stores to meet physiological demands (Whyte *et al.* 1986; Rhodes 1991; Smith and Sheeley 1993).

The average increase in carcass fat (g) from October to November-December during wet 2002, was 26% for males and 42 to 93% (HY) for females. During dry 2003, females did not increase carcass fat (g), although males did so by 34%. Compared to other waterfowl, pintails did not increase carcass fat levels to the same magnitude. Whyte *et al.* (1986) reported that mallards increased carcass fat reserves from autumn to early winter in 1979-1982 by 40% (AHY males), 14% (HY males), 35% (AHY females), and 31%

(HY females). Rhodes (1991) found that American Wigeon augmented carcass fat reserves during 1988-1989 (AHY males 65%, AHY females 121%, HY males 74%, HY females 182%), and did so to a higher level than either mallards or pintails. The failure of pintails to increase body fat as much as other species, with the exception of females during 2002, suggests that foods unique to pintails may be limited at that time. Because of the declines in body condition of pintails arriving in the PLR during the past two decades, protection of playas should be a priority to allow for management of high quality habitats for waterfowl in the future.

Pintails need sufficient wetland habitats and food resources upon arrival in the PLR to recover from migration and acquire carcass fat reserves for the wintering period. This trend of acquiring carcass fat upon arrival to a wintering area was also documented in the Sacramento Valley of California (Miller 1986). Body condition of pintails normally peaks in the PLR during early winter (Smith *et al.* 1992; Smith and Sheeley 1993; Moon *et al.* 2007), and wetland habitats are critical at that time to provide adequate food resources for pintails. Because body condition peaks during early winter, PLR area managers should ensure playas are available upon pintail arrival in the fall and during the entire period that pintails are present in the region. We recommend managing wetland complexes (several managed playas in one area) to provide different sources of food within a relatively short distances to reduce the use of fat stores during feeding flights.

Body condition differences by subregion during 2002 indicate underlying geographic variation in habitat conditions. Although we found no differences in body condition during 2003, there was a biological tendency for differences to occur between north and south subregions. Differences were likely undetected due to poor habitat quality and limited quantity across all portions of the PLR. As the result of the differences in body condition among habitats, future studies must sample pintails from representative areas across the PLR to ensure unbiased pintail samples.

We recommend sampling pintails across the wintering period and in several different areas (north and south) of the region to fully assess trends in body condition. Identification of factors affecting pintail ecology in north and south subregions will help managers better plan habitat management programs (i.e. mitigate disturbance and distribution of habitats). We recommend that future research examine the underlying causes of relatively low carcass fat in pintails sampled in northern trapping areas. Additionally, perpetual protection of playas will ensure their ability to be available to pintails during migration and wintering periods, pending management and adequate rainfall. This will support foraging on high quality food resources to fuel accumulation of carcass fat reserves and increase over-winter survival (Moon and Haukos 2006).

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