

BODY MASS AND LIPID CONTENT OF SHOREBIRDS OVERWINTERING ON THE SOUTH TEXAS COAST

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Abstract.—Three species of shorebirds were collected at bimonthly intervals in 1979–1980, from the time of their arrival in early autumn to mid-February, on the south Texas coast. Female Long-billed Dowitchers (*Limnodromus scolopaceus*) and Western Sandpipers (*Calidris mauri*) were heavier ($P < 0.05$) than males, but the reverse was true for American Avocets (*Recurvirostra americana*). Lipid content, relative to whole body mass, did not differ ($P > 0.05$) between sexes in any of the three species. During the wintering period, fat stores in Long-billed Dowitchers and Western Sandpipers declined 70% and 44%, respectively, but not in American Avocets. Lipid content was highly correlated ($P < 0.001$) with body mass in all three species, providing further evidence that fat accumulation is responsible for the major variation in total mass of some shorebird species.

PESO Y CONTENIDO DE LÍPIDOS EN PLAYEROS QUE PASAN EL INVIERNO EN LA COSTA DEL SUR DE TEXAS

Síopsis.—Tres especies de playeros fueron capturados a intervalos bimensuales entre 1979–1980 desde el momento de su llegada en el otoño hasta mediados de febrero, en la costa de la parte sur de Texas. Hembras de *Limnodromus scolopaceus*, y *Calidris mauri* pesaron más ($P < 0.05$) que los machos, pero lo inverso resultó para *Recurvirostra americana*. No se encontró diferencia ($P > 0.05$) sobre la cantidad de lípidos en relación a la masa corporal entre los sexos de las tres especies. Durante el período invernal, la cantidad de lípidos almacenados por parte de *L. scolopaceus* y de *C. mauri* se redujo en un 70% y 44%, respectivamente. No se encontraron cambios particulares en la otra especie estudiada. Se encontró una correlación ($P < 0.001$) entre la cantidad de lípidos y la masa corporal en las tres especies. Este trabajo provee evidencia adicional en referencia a que la acumulación de grasa es responsable de las variaciones de la masa total de algunas especies de playeros.

The Laguna Madre, an extensive breeding, wintering, and nursery ground for fish and wildlife, stretches for over 200 km along the south Texas coast. Man-made agricultural drains entering the Laguna Madre near Port Mansfield, Texas (Fig. 1), have expansive mudflats where large numbers of migratory shorebirds overwinter. These canals drain thousands of ha of cropland, which are in production year-round and receive repeated pesticide applications (Jahrsdoerfer and Leslie 1988). As part of a study to determine the temporal accumulation and potential effects of pesticides in migrant shorebirds using these drains, we collected specimens during fall and winter 1979–1980 for chemical analyses (Mitchell and White 1982, White et al. 1983).

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There is increased interest in shorebird conservation and many recent studies have emphasized the importance of accurate knowledge of shorebird distribution and abundance (Myers 1983, Myers et al. 1987, Senner and Howe 1984, Wunderle et al. 1989). However, there is little information available on body condition of migrant shorebirds, especially on their Gulf coast wintering grounds. Here we report body mass and lipid content of specimens collected during fall and winter 1979–1980 along the south Texas coast.

METHODS

Long-billed Dowitchers (*Limnodromus scolopaceus*), Western Sandpipers (*Calidris mauri*), and American Avocets (*Recurvirostra americana*) were collected at approximately bimonthly intervals during October 1979–February 1980. Western Sandpipers also were collected at the initiation of their fall migration in late July 1979, and one collection of Short-billed Dowitchers (*Limnodromus griseus*) was obtained on 8 August. Birds were shot, placed individually in tagged polyethylene bags, kept on wet ice, and frozen at the end of the day. At the time of freezing, birds were double-bagged to retard desiccation during storage. Birds were collected as they were actively feeding on mudflats at the outlets of agricultural drains near Port Mansfield, Texas (Fig. 1). It is possible that birds taken in late July and in October would have migrated farther south, but we assumed that birds collected in December and in February were wintering residents. Our sampling scheme called for the collection of 20 Long-billed Dowitchers and Western Sandpipers and 10 American Avocets at each bimonthly period, but these numbers were not always attainable. Also, because of different migration patterns, only Western Sandpipers were available for collection in late July.

Before birds were processed for pesticide analysis, they were thawed, blotted with paper towels to remove excess moisture, and weighed. Sex was determined internally. Birds were skinned and adipose tissue adhering to the skin was carefully removed and retained with the carcass. Relative lipid content (% of wet weight) of carcasses was determined at the Patuxent Wildlife Research Center, Laurel, Maryland, following Cromartie et al. (1975) and Kaiser et al. (1980).

The body mass and lipid content data were normally distributed (Shapiro and Wilk 1965), so we used two-way analysis of variance (ANOVA) to test for sex and time-period effects and one-way ANOVA with Tukey's HSD multiple comparison procedure to test for differences among means. Correlation analysis was used to determine relationships between body mass and carcass lipid content.

RESULTS

Dowitchers were present on the south Texas coast in early August, but our first collection contained only Short-billed Dowitchers based on plumage characteristics and wing and bill measurements. During subsequent collections, no other Short-billed Dowitchers were obtained, sug-

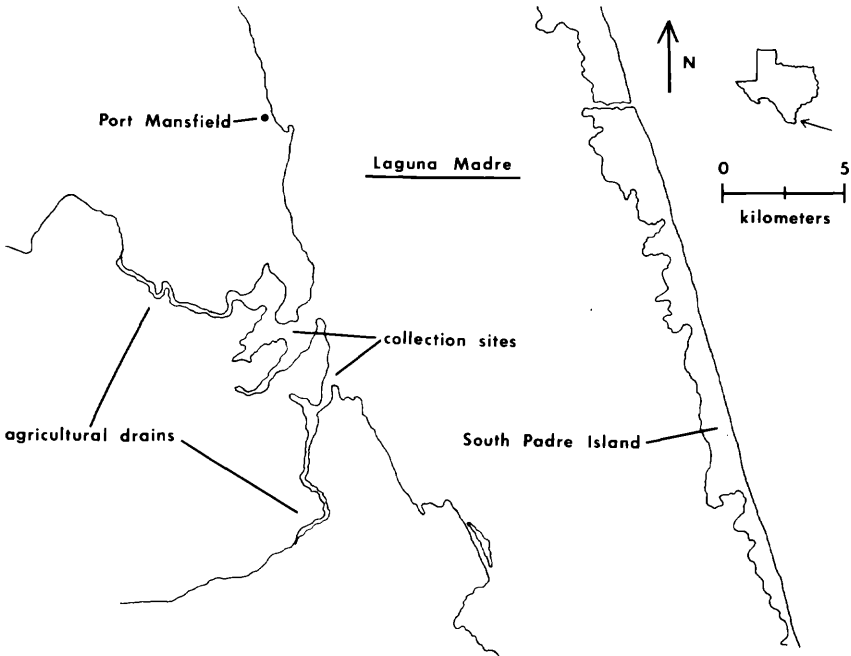


FIGURE 1. Sites at the outlets of agricultural drains near Port Mansfield, Texas, where shorebirds were collected during fall and winter, 1979–1980.

gesting that most of them probably wintered farther south. Body mass of males ($n = 12$) averaged 112 ± 4.2 (SE) g and that of females ($n = 8$) 119 ± 3.5 g. Lipid content (relative to total body mass) averaged 7.2 ± 1.35 (SE) % in males and 7.4 ± 0.7 % in females. There was no difference in mean body mass ($t = 1.28$, $df = 18$, $P > 0.05$) or relative lipid content ($t = 0.09$, $df = 18$, $P > 0.05$) between the sexes.

Long-billed Dowitchers were present in the study area during the second week of October. There was much variation in body mass in both sexes upon their arrival on the Texas coast (Table 1). Two-way ANOVA indicated no interactive effects of sex and time-period on body mass ($F = 0.37$, $df = 2$, $P > 0.05$) or lipid content ($F = 1.72$, $df = 2$, $P > 0.05$). Females were heavier ($F = 34$, $df = 1$, $P < 0.001$) than males, and mean body mass remained constant in males ($F = 3.37$, $df = 2$, $P > 0.05$) and females ($F = 2.79$, $df = 2$, $P > 0.05$) over time. In contrast, females were no fatter ($F = 3.06$, $df = 1$, $P > 0.05$) than males, but lipid levels in both sexes declined significantly over the wintering period (Table 2). The decrease in relative lipid levels averaged 70% between October and February. Overall, percent lipid was highly correlated ($r = 0.66$, $df = 53$, $P < 0.001$) with body mass.

Western Sandpipers were the first migrant shorebirds observed in the study area, arriving in the third week of July. The two-way ANOVA

TABLE 1. Body mass (mean \pm SE) of shorebirds collected on the south Texas coast.

Species	Period	Body mass (wet weight, g)	
		Males	Females
Long-billed Dowitcher	11 Oct 79	103 \pm 3.1 (9) ^a	115 \pm 2.9 (11)
		89-120 ^b	95-131
	1 Dec 79	100 \pm 1.7 (5)	110 \pm 1.9 (15)
		97-103	101-121
	15 Feb 80	95 \pm 1.6 (10)	110 \pm 2.4 (5)
		88-103	105-115
Western Sandpiper	25 Jul 79	28 \pm 0.6 (13)	29 \pm 0.9 (7)
		24-30	26-32
	11 Oct 79	29 \pm 0.6 (9)	32 \pm 0.5 (11)
		27-32	29-35
	1 Dec 79	— ^c	28 \pm 0.3 (20)
			25-30
	15 Feb 80	23 \pm 0.5 (15)	26 \pm 0.8 (5)
		19-25	23-28
American Avocet	11 Oct 79	382 \pm 14.7 (5)	334 \pm 26.1 (5)
		342-428	262-393
	1 Dec 79	417 \pm 10.1 (7)	341 \pm 7.8 (3)
		382-440	326-350
	15 Feb 80	316 \pm 10.0 (3)	340 \pm 7.9 (7)
		297-331	313-372

^a Sample size.^b Extremes.^c No males obtained.

model indicated no significant interaction between sex and time-period for body mass ($F = 1.04$, $df = 2$, $P > 0.05$) or lipid content ($F = 0.02$, $df = 2$, $P > 0.05$). Females were heavier than males only in October ($F = 9.26$, $df = 1$, $P < 0.001$) and February ($F = 11$, $df = 1$, $P < 0.001$) (Table 1). Percent lipid was similar ($F = 1.18$, $df = 1$, $P > 0.05$) for males and females (no males were obtained in December) among collection periods (Table 2). Birds collected in February were leaner than those collected in July, an average decline in lipid content of 44%. Correlation analysis indicated a highly significant ($r = 0.66$, $df = 78$, $P < 0.001$) relationship between relative lipid content and body mass in Western Sandpipers.

A few American Avocets were present at the study site in late August,

TABLE 2. Carcass lipid content relative to total body mass (mean \pm SE) of shorebirds collected on the south Texas coast.

Species	Period	Carcass lipid content (wet weight, %)		
		Males	Females	Combined ^a
Long-billed Dowitcher	11 Oct 79	8 \pm 1.2	12 \pm 1.5	10 \pm 1.0A ^b
		(9) ^c	(11)	(20)
	1 Dec 79	5-14 ^d	4-22	4-22
		6 \pm 0.2	6 \pm 0.5	6 \pm 0.3B
		(5)	(15)	(20)
	15 Feb 80	5-6	3-9	3-9
3 \pm 0.3		3 \pm 0.4	3 \pm 0.2C	
		(10)	(15)	
		2-5	2-5	
Western Sandpiper	25 Jul 79	9 \pm 0.9	8 \pm 1.9	9 \pm 0.9A
		(13)	(7)	(20)
	11 Oct 79	4-15	4-19	4-19
		11 \pm 1.2	11 \pm 0.8	11 \pm 0.7B
		(9)	(11)	(20)
	1 Dec 79	5-16	8-16	5-16
		— ^e	9 \pm 0.4	9 \pm 0.4AB
			(20)	(20)
15 Feb 80	7-13	7-13	7-13	
	5 \pm 0.5	5 \pm 0.4	5 \pm 0.4C	
	(15)	(5)	(20)	
	3-11	4-6	3-11	
American Avocet	11 Oct 79	9 \pm 1.8	10 \pm 2.4	9 \pm 1.4A
		(5)	(5)	(10)
	1 Dec 79	4-14	4-18	4-18
		15 \pm 1.2	9 \pm 1.6	13 \pm 1.3A
		(7)	(3)	(10)
	15 Feb 80	9-18	8-13	8-18
		7 \pm 0.6	10 \pm 0.6	9 \pm 0.7A
		(3)	(7)	(10)
	6-8	8-12	6-12	

^a Sexes combined for statistical comparisons since no sex differences were indicated.

^b Means for each species within the column with different letters differ significantly (ANOVA with Tukey's test, $P < 0.05$).

^c Sample size.

^d Extremes.

^e No males collected.

but numbers were not sufficient for collecting until mid-October. Body mass was highly variable for both sexes among collections (Table 1). Small sample sizes and uneven distribution of the sexes within collections further complicated statistical interpretations. Overall, males were heavier ($F = 6.8$, $df = 1$, $P < 0.01$) than females. Lipid content was similar ($F = 0.01$, $df = 1$, $P > 0.05$) in both sexes and levels remained unchanged throughout the study (Table 2). As in the other species, lipid content was positively correlated ($r = 0.67$, $df = 28$, $P < 0.001$) with body mass.

DISCUSSION

We found no reports of body mass or lipid content in shorebirds wintering on the Gulf coast with which to compare our results. However, body mass in the species we studied was within the range of values reported by others (Hamilton 1975, Johnsgard 1981, Senner 1979). Mascher and Marcstrom (1976) reported no differences in body mass of Dunlins (*Calidris alpina*) determined before they were killed and after being frozen for about a year; therefore, we believe our estimates of body mass for frozen specimens are equivalent to those of live birds. Also, we recognize that skinned carcasses do not reflect total body lipid. Although efforts were made to retain all fat with the carcass, our lipid estimates may be low since skins were discarded (White et al. 1983).

Significant sex differences in body mass of Long-billed Dowitchers and Western Sandpipers were consistent throughout the study, even though individual mass was highly variable. Females were heavier than males, probably as a result of larger body size (wing and bill length) in females of both species (Johnsgard 1981). Sex differences in body mass of American Avocets were not so clearly defined. Hamilton (1975) states that males are larger than females, but because of small sample sizes and highly variable mass in individuals, we could not confirm this relationship for all collection periods. Percent lipid (relative to total body mass) was highly correlated with body mass in all three species. Thus, we attribute much of the variation in body mass to the degree of fat accumulation, as has been shown for Dunlins (Mascher and Marcstrom 1976).

Our most striking results were that Long-billed Dowitchers and Western Sandpipers showed dramatic declines in fat stores over the wintering period (Table 2). From the time of their arrival on the Texas coast to mid-February, lipid loss in these two species averaged 70% and 44%, respectively. Lipid levels in American Avocets remained stable throughout the study, but our small sample sizes may have biased this observation. It has long been recognized that many species store fat as their primary energy source before making long migrations (Kendeigh et al. 1960, Nisbet et al. 1963, Odum et al. 1961). Birds were not collected beyond 15 February because we wanted our samples to represent birds wintering on the Texas coast. Birds collected in March or later could be migrants from Latin America and would not reflect local uptake of pesticides, our primary objective (White et al. 1983). Thus, we do not know if birds replenished fat stores before departing for northern breeding grounds. Body mass of male Western Sandpipers during spring migration along the Pacific coast averaged about 25 g at Baja, about 30 g at Vancouver Island midway along their migration route, and about 25 g upon their arrival at breeding areas in northern Alaska (Senner 1979). Their mean mass (March–April) at Baja was similar to what we report for males (23 g) in mid-February. This comparison suggests (at least for males) that Western Sandpipers do not accumulate substantial fat deposits before their northward departure from the Texas coast, but acquire needed

reserves along the way. This same pattern may hold true for Long-billed Dowitchers.

The reasons that Long-billed Dowitchers and Western Sandpipers experienced lipid loss during winter in Texas are unknown. Since thousands of shorebirds used the mudflats at our study site, food depletion may have been a contributing factor (Lank 1983, Schneider and Harrington 1981). Also, adverse weather conditions in winter are infrequent along the south Texas coast, and the costs of storing and carrying reserves may exceed the benefits; waders wintering in northwestern Africa showed no temporal increases in mass, unlike those in northwestern Europe where winters are harsh (Dick and Pienkowski 1979).

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