sandy loam soils largely devoted to cultivation of grain sorghum; the balance was rangeland. Our study (Crawford and Bolen, Texas J. Wildl. Manage. 40: 96–104, 1976) of land use and Lesser Prairie Chicken populations in this area has indicated significant positive correlations, respectively, between the percentage of rangeland, percentage of minimum tillage on the cropland, and the percentage of deep sand soils surrounding lek sites. In fact, lek populations in areas where there was only rangeland were not as large as those where there was some amount of cropland.

Whereas a strong reliance on cultivated crops during the fall in west Texas is indicated, considerable diversity is demonstrated in the diet. Shrubs, forbs, grasses and insects, as well as cultivated crops are important. We found large amounts of grain sorghum in the diet throughout the study. Field observations in the late fall and winter also emphasize the importance of minimum tillage as an agricultural practice favoring winter food availability in areas where grain sorghum is produced.

We wish to emphasize that the importance of cultivated grains in the diet should not overshadow the necessity of sizable tracts of native range needed to support this species. Cultivation, although important for feeding, provides little else regarding the habitat necessary for Lesser Prairie Chickens throughout the year.

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FAT CONTENT AND FLIGHT RANGE IN SHOREBIRDS SUMMERING ON ENEWETAK ATOLL

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Many shorebirds (particularly the long-distance migrants) remain on their wintering grounds during the boreal summer. Presumably, this nonbreeding contingent is composed almost exclusively of first-year birds. Literature pertaining to migratory arrest and its possible causative factors was reviewed by McNeil (1970) and Johnson (1973).

The fat cycle of shorebirds has not been examined widely. Major studies are limited to work conducted in the Gulf of St. Lawrence and northeastern Venezuela (McNeil 1969, 1970, McNeil and Cadieux 1972 a,b). The Venezuela research was concerned both with migrants and shorebirds summering on the winter range. Johnston and McFarlane (1967) presented data on lipid content in American Golden Plovers (*Pluvialis dominica fulva*) collected at Wake Island. Their specimens were obtained during the migratory and wintering seasons, and hence do not reflect the lipid status of birds summering in the Pacific. To our knowledge, this paper is the first to consider the latter topic.

Johnson carried out field work at Enewetak Atoll (formerly spelled "Eniwetok") in the northwest Marshall Islands (approximately 11°N, 162°E) during the period from 4 July through 17 July, 1973. Birds were collected on Aomon, Biijiri, Enewetak, and Rojoa islets. The species studied are listed in table 1.

Specimens were weighed immediately upon collection, and skinned several hours later (skins were needed for other research). When skinning, efforts were made to retain as much subcutaneous fat as possible on the carcasses. The latter were then preserved in a 4% aqueous solution of formaldehyde and shipped to Morton for extraction of lipids. In the extraction procedure each carcass was dehydrated in a vacuum oven at 55°C, homogenized, and extracted with petroleum ether in a soxhlet apparatus for 24 hours. Any residual water was taken up with anhydrous sodium sulfate, the extract was filtered and the ether evaporated.

The data obtained are summarized in table 1. Coincident to skinning, some quantity of fat was unavoidably lost from each specimen. Hence, the values shown are minimal relative to actual lipid stores. It is reasonable to assume that the fat lost from each bird was proportional to its total fat content, and that the data are comparable throughout.

Fat levels in the Enewetak specimens (table 1)

TABLE 1. Fat content of summering shorebirds.

	Body wt. (g)[b]	Ether-extractable fat (g)[b]	Fat content as % of body wt.[b]
American Golden Plover (*Pluvialis dominica fulva*) [17][a]	116.9(102.5–129.8)	3.4(1.9 – 5.5)	3.0(1.7– 4.6)
Whimbrel (*Numenius phaeopus*) [2]	401.2(384.5–418.0)	23.9(22.1–25.8)	6.0(5.3– 6.7)
Bristle-thighed Curlew (*Numenius tahitiensis*) [7]	493.9(383.0–585.0)	33.6(12.7–63.1)	6.6(3.3–10.8)
Wandering Tattler (*Heteroscelus incanus*) [3]	115.8(96.5 –132.5)	3.6(2.5 – 4.3)	3.0(2.6– 3.6)
Ruddy Turnstone (*Arenaria interpres*) [6]	97.1(89.1 –108.0)	3.9(2.8 – 4.7)	4.0(2.9– 4.7)

[a] Number of specimens examined.
[b] Figures represent mean and range.

TABLE 2. Approximate capacity for sustained flight.

	Body wt. (g) and ether-extractable fat (g)[a]		Flight speed (mph)[b]	Flight range (miles)[c]
American Golden Plover	108.8(1.9),	119.5(5.5)	65	160–430
Whimbrel	418.0(22.1),	384.5(25.8)	45	470–590
Bristle-thighed Curlew	383.0(12.7),	585.0(63.1)	35	225–820
Wandering Tattler	96.5(2.5),	118.5(4.3)	45	160–235
Ruddy Turnstone	97.5(2.8),	90.0(4.2)	40	155–250

[a] For each species, the data represent the two specimens with minimum-maximum flight ranges, respectively.
[b] Flight speed estimates from several sources where literature summaries of such data and/or direct speed measurements are given: Cooke (1933), Meinertzhagen (1955), Johnston and McFarlane (1967), McNeil (1970).
[c] The formula used by McNeil (1969, 1970) and McNeil and Cadieux (1972 a,b) was used to calculate flight range: FR = flight range in miles $= F \times S \times 9.1$ kcal/FM; where F is weight of fat in grams; S is flight speed in miles per hour; 9.1 is the caloric value of 1 gram of fat (Johnston 1970); and FM is flight metabolism. The latter is estimated by the equation of Raveling and LeFebvre (1967): $\log FM = \log 37.152 + 0.744 \log W \pm 0.074$, where W is body weight in kilograms.

were very similar to those reported for shorebirds summering in Venezuela (McNeil 1970). McNeil's findings show lipid content ranging from approximately 3 to 6% of body weight. In contrast, premigratory or intramigratory fat in shorebirds varies from about 17 to 50% of body weight (Johnston and McFarlane 1967, McNeil 1970, Page and Middleton 1972).

Johnston and McFarlane (1967) extracted lipids from 12 Golden Plovers collected at Wake Island in April, 1964. The result was a bimodal distribution with fat content in one group of plovers ranging from 31 to 43g, and from 11 to 15g in the other. Although the authors did not consider the possibility, it is conceivable that the bimodal pattern reflects a breeding population ready for northward migration as opposed to a nonbreeding population scheduled to remain on the winter range. Plovers are absent from Wake Island during the summer (Johnston and McFarlane 1967), and this leads us to speculate further. Taking into account places where summering plovers do occur, it is possible that birds with low fat reserves depart Wake for areas with more extensive habitat. Their energy supplies could readily sustain southward flights into Micronesia or northeastward movements to the Hawaiian Islands.

Whimbrels (*Numenius phaeopus*) and Bristle-thighed Curlews (*N. tahitiensis*) displayed somewhat greater quantities of fat (table 1). The highest values occurred in three curlews with lipids ranging from 8.0 to 10.8% of body weight. Possibly, these findings relate to the fact that Whimbrels and curlews were nearing completion of their prealternate molt, whereas the remaining specimens were at other stages in the molt cycle (Johnson, in press).

The approximate flight ranges for representative birds (leanest compared to fattest) in each species are shown in table 2. Such estimates are inherently crude since many variables (flight speed, wind direction, etc.) are difficult to delimit. Presumably, the three curlews mentioned above could have made sustained flights of 600 to 800 miles, while flight ranges for most other specimens were substantially less. All specimens were physiologically incapable (fat reserves too low) of the long-distance migration necessary to reach breeding areas.

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