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 crop-land.

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 culti-

FAT CONTENT AND FLIGHT RANGE IN SHOREBIRDS SUMMERING ON ENEWETAK ATOLL

OSCAR W. JOHNSON AND MARTIN L. MORTON

Many shorebirds (particularly the long-distance mi-
grants) remain on their wintering grounds during the
boreal summer. Presumably, this nonbreeding con-
tingent is composed almost exclusively of first-year
birds. Literature pertaining to migratory arrest and
its possible causative factors was reviewed by Mc-
Neil (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 Pa-
cific. 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 Mar-
shall Islands (approximately 11°N, 162°E) during the period from 4 July through 17 July, 1973. Birds
were collected on Aomon, Biijiri, Enewetak, and Ro-
joa islets. The species studied are listed in table 1.

Specimens were weighed immediately upon col-
lection, and skinned several hours later (skins were
needed for other research). When skinning, efforts
were made to retain as much subcutaneous fat as pos-
sible 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
common oven at 55°C, homogenized, and extracted
with petroleum ether in a soxhlet apparatus for 24
hours. Any residual water was taken up with anhy-
drous 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 un-
avoidably 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>
<thead>
<tr>
<th>Species</th>
<th>Body wt. (g)</th>
<th>Ether-extractable fat (g)</th>
<th>Fat content as % of body wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Golden Plover</td>
<td>116.9(102.5-129.8)</td>
<td>3.4(1.9 – 5.5)</td>
<td>3.0(1.7– 4.6)</td>
</tr>
<tr>
<td>Whimbrel (Numenius phaeopus)</td>
<td>401.2(384.5–418.0)</td>
<td>23.9(22.1–25.8)</td>
<td>6.0(5.3– 6.7)</td>
</tr>
<tr>
<td>Bristle-thighed Curlew (Numenius tahitiensis)</td>
<td>493.9(383.0–585.0)</td>
<td>33.6(12.7–63.1)</td>
<td>6.6(3.3–10.8)</td>
</tr>
<tr>
<td>Wandering Tattler (Heteroscelus incanus)</td>
<td>115.8(96.5–132.5)</td>
<td>3.6(2.5 – 4.3)</td>
<td>3.0(2.6– 3.6)</td>
</tr>
<tr>
<td>Ruddy Turnstone (Arenaria interpres)</td>
<td>97.1(89.1–108.0)</td>
<td>3.9(2.8 – 4.7)</td>
<td>4.0(2.9– 4.7)</td>
</tr>
</tbody>
</table>

* Figures represent mean and range.

** Figures represent mean and range.

** Number of specimens examined.
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).

Johnson 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. tahitienlis) 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 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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