Varying degrees of aggressive interaction occurred at the Pacific Palisades site to the limits of our observations at 22:00. During aggressive encounters the birds call repetitively, emitting sounds which can be likened to: "psweer", "psweer wit", "sweerit" and "pseer". The sounds are relatively high-pitched, and have a melodious whistled quality. From his residence nearby, Johnson heard these aggression-related calls coming from the Kailua Intermediate School roost at various hours throughout the night over the entire wintering period.

Diurnal activities

Several hundred golden plovers winter on the Kaneohe Marine Corps Air Station (KMCAS) near Kaneohe on the windward coast of Oahu. The base contains attractive plover habitats, including large lawns, grassy runway borders and medians, and saline marshes. KMCAS has numerous flat-roofed buildings but we were unable to locate any nocturnal roosts on them. Instead, we found extensive diurnal use of roofs with large flocks of plovers engaged in loafing, sleeping and preening. One site (consisting of the roofs of four adjacent buildings) was particularly attractive to the birds, and approximate counts for eight dates in December, January, March and April ranged between 50 and 150 plovers on these roofs simultaneously. On various occasions we saw groups of plovers departing from the roofs in the late afternoon and flying in the direction of the Nuupia Ponds (saline marshes managed as bird sanctuaries) where there appear to be important roosting sites. This suggests that roofs are not preferred for roosting when natural habitats are available.

In contrast to the nocturnal behaviour described earlier, little aggression was observed in the diurnal aggregations. Loafing, preening and sleeping birds tolerated each other in close proximity (often 0.5 m or less) without agonistic responses. We made several observations of plovers occupying feeding territories in a small park in a residential area of Kailua. When disturbed by people using the park, the birds generally flew to the safety afforded by the roofs of adjacent houses. After preening and loafing for varying periods of time, they returned to their territories well after the disturbance had passed. Whether the birds were also using these residential roofs as nocturnal roosts was not determined. Since the Kailua High School was nearby, these plovers may have been members of the roosting contingent there.

Acknowledgemnts

We are grateful to officials of the Honolulu Public School System for permission to make night time observations at the Pacific Palisades site. At KMCAS, Col. M.H. Sautter kindly granted access, and Staff Sgt. A. Cox provided helpful liaison. Patricia M. Johnson rendered invaluable field assistance. The data reported here were obtained coincident to a larger project on the wintering biology of golden plovers conducted by Johnson during a sabbatical year in the Department of Zoology, University of Hawaii. The many courtesies extended by members of that department are acknowledged with gratitude.

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SOME NOTES ON SEASONAL FLUCTUATIONS IN THE WEIGHT OF DUNLIN *CALIDRIS ALPINA* ON THE FRASER RIVER DELTA, BRITISH COLUMBIA

by G. W. Kaiser and M. Gillingham

Introduction

While one would expect fluctuations in the mean weight of a population to follow various environmental stresses, this may not in fact always be the case. For instance, fluctuations in weight of populations of Dunlin in the British Isles cannot consistently be related to periods of bad weather, and Pienkowski et al. (1979) have proposed two theories to account for the pattern of weight changes observed during the winter:

1. Food abundance is high in early winter and the birds store surplus energy intake as fat. As winter progresses, invertebrates become less active and burrow deeper, the daylight period becomes shorter and night feeding is probably less efficient. The accumulated fat reserve is used to compensate for inadequate feeding and the bird loses weight until the weather improves in March.
2. The fat reserves are a form of insurance against difficulties in meeting food requirements. High reserves are maintained through December and January, but may become a disadvantage when the probability of poor weather is reduced in February and March, so fat reserves are reduced.

The purpose of this paper is to show how contrasting conditions in the Fraser River Delta and Britain can be used to support one of these hypotheses.

Methods

From December 1976 to May 1980, 2806 Dunlin were banded in the Fraser River Delta, British Columbia, Canada (49°01'N 123°00'W). The birds were mist-netted at high tide, banded, weighed and measured to assist in sex determination. The plumage characteristics for age determination have been described by Prater et al. (1977). In at least two thirds of the population, the length of the exposed culmen identifies the sex (Page 1974).

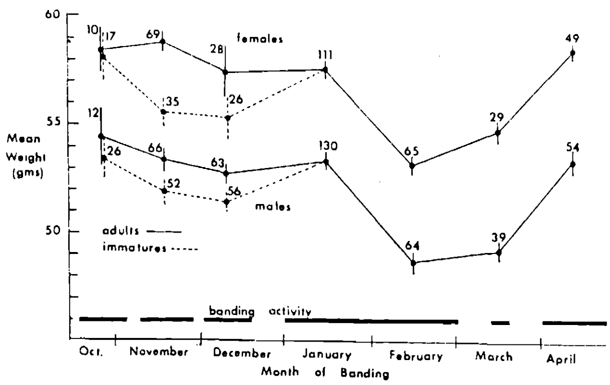

Figure 1. Mean weights of Dunlin captured in the Fraser River Delta, 1978-79.

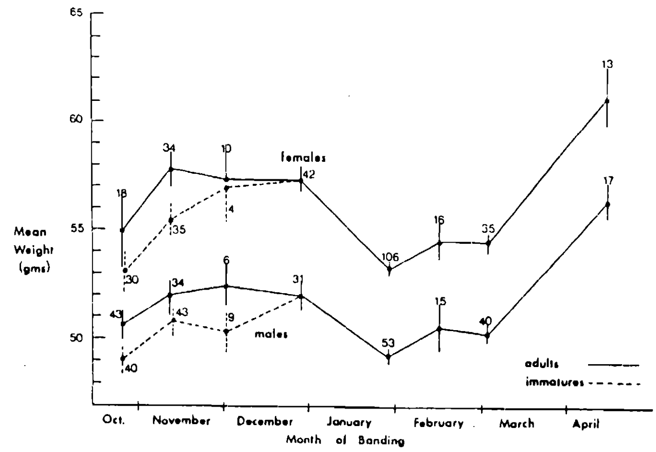

Figure 2. Mean weights of Dunlin captured in the Fraser River Delta, 1979-80.

Results

Weight fluctuations of Dunlin during the winters of 1978-79 and 1979-80 are shown in Figures 1 and 2, respectively.

1. Birds were sexed on the basis of measurements as follows: those with exposed culmen less than or equal to 37.7 mm were presumed to be male, whereas those with exposed culmen greater than or equal to 39.8 mm were presumed to be female (Page 1974). Use of measurements to separate sexes will result in a biased sample by selecting the larger females and smaller males, since those birds in the overlap zone are excluded: birds in the excluded group had weights intermediate to those in the groups designated as male and female. Birds sexed as females in this manner were generally 4-5 g heavier than those classified as males. Means of the two groups varied in a similar manner throughout the winter.

2. Immature Dunlin tended to weigh less than adult birds, but the difference was very small after December. Up to the end of December, the mean weight of immatures was significantly different from that of adults ($p < .05$). From early January, the mean weights of immatures remained consistently lower than those of adults, but the difference was not statistically significant and the two groups have been combined.

3. Mean weights of all age and sex classes showed little fluctuation between early November and mid January. In 1977 and 1979 there was a slight increase immediately after arrival in October.

4. There was a significant decrease in the mean weights of all age and sex classes in February that lasted into March, when the birds began their moult into breeding plumage.

5. Mean weights for migrant birds in April were not significantly different from mean weights observed in November.

6. The largest differences between 1978-79 and the other two seasons occurred in early autumn. Dunlin migration in October 1978 was fairly early and we may have missed catching birds that showed any migration stress and/or heavier birds which had already put on weight for further migration may have already departed. The mean weight of samples in November 1977 and 1979 was two to three grams heavier than samples from October (Figure 2).

7. There was no significant change in the exposed culmen length or wing length among the 45 recaptured birds, and weight changes between captures mirrored fluctuations in the population as a whole.

Discussion

Dunlin in the lower mainland of British Columbia use many areas that are threatened by industrial and urban effluent and our studies were undertaken to investigate critical habitat factors that might affect populations and to understand the winter food requirements of the birds. We anticipated, for instance, that the weights of birds captured for banding might fluctuate with various weather conditions and demonstrate periods of stress on the birds. However, we found no apparent direct relationship between changes in weight of the samples that we captured and the observable parameters of environmental hardship (see below).

Pienkowski et al. (1979) investigated winter weight patterns of large samples of Dunlin banded at the Wash on the east coast of England. There was a large increase in weight from October to a peak in December, an abrupt decrease in February and a subsequent increase associated with spring migration. Smaller samples from the south and west of England and western Ireland showed a similar pattern, except that there was only a small change between early November and mid January. It is this latter pattern that we found to be followed by Dunlin wintering in southern British Columbia and which Page (1974) reported from California.

Pienkowski et al. (1979) discussed two hypotheses to explain these fluctuations. The first was based on the declining availability of food items as winter progressed and the second depended on the species' ability to respond to the probability of future stress. The limited information available to us at this time seems to support the second theory.

In the lower mainland of British Columbia, December and January appeared to be particularly inhospitable for Dunlin, but the birds maintained their body weight throughout this period. In both 1978 and 1979, there were long spells of freezing weather at the end of December. The mean temperatures for January were -0.4°C in 1978 and 0.2°C in 1979. Large pans of ice formed on the tidal flats as rain and run-off from agricultural lands froze. At the same time, tides were high in the day and low at night. In December, for instance, there were only two hours of daylight when the tide fell below 3 m and the mud flats were exposed.

This severe weather regime was not accompanied by any known decrease in the density of benthic invertebrates (Levings et al. 1978). An earlier decrease, in November, was not accompanied by a parallel decrease in Dunlin weights. It is possible that the nocturnal tides, which are very low during these months, expose previously unavailable and unexploited communities of invertebrates.

In February, when mean weights of Dunlin reached their lowest point, the weather was more moderate, with maximum temperatures reaching 15°C and means near 5°C. The tidal cycle had progressed so that there were more than 50 hours of daylight with the level below 3 m, representing a marked increase in the availability of daylight feeding time.

The subsequent increase in weight that began in March was accompanied by a body moult to breeding plumage and it preceded the eventual migration to Alaska in April.

Conclusions

Observations from the lower mainland of British Columbia did not support the hypothesis that the winter weight fluctuations of Dunlin at this locality are a response to stresses such as a depletion of food items, a decrease in food availability and a dependence on night feeding. The observations that weight decreases at a time when food appears to be more available, when the weather is milder and when there is more opportunity for daylight feeding, support a second hypothesis that weight reserves represent a response to the probability of poor weather during the winter.

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DISTRIBUTION AND ECOLOGY OF SHOREBIRDS IN ALASKA'S COASTAL ZONE: A REVIEW OF STUDIES IN THE OUTER CONTINENTAL SHELF ENVIRONMENTAL ASSESSMENT PROGRAM

by Peter G. Connors

With the impetus of proposed oil exploration on the Alaska continental shelf, the U.S. Department of the Interior began in 1975 the Outer Continental Shelf Environmental Assessment Program (OCSEAP) to guide decisions concerning Alaskan oil development. OCSEAP, administered by the National Oceanic and Atmospheric Administration (NOAA) and the Bureau of Land Management (BLM), has since provided financial and logistic support for hundreds of researchers from universities, state and federal agencies, and independent research organizations. Recognizing that shorebirds figure among the most prominent animal groups potentially affected by coastal oil development, OCSEAP has encouraged studies of the distribution and ecology of shorebirds at a variety of sites in coastal Alaska. To alert workers unfamiliar with OCSEAP to the kinds of information being developed within the program, I shall review below the projects most involved with the coastal shorebird research.

Before 1975, much shorebird work had been completed near Barrow by Pitelka and his coworkers and several studies added information at other coastal sites, but emphasis was on nesting periods and habitats, rather than on shoreline activities. Non-OCSEAP research has continued at several sites in recent years (e.g. Myers, J.P. and F.A. Pitelka, 1980. Seasonal abundance and habitat use patterns of shorebirds at two sites in northern Alaska. Wader Study Group Bulletin 29: 28-30).

The net result of these five years of OCSEAP-sponsored shorebird research has been a dramatic expansion in our understanding of migration routes, breeding distributions, habitat dependences, and susceptibilities to development of shorebirds along the coast of Alaska. We now know the breeding shorebird communities at a series of coastal sites from the Canadian border west and south to Nelson Lagoon (Figure 1), the timing of movements by migrants through these areas, and the seasonal patterns in habitat use by common species at particular sites. Several areas - among them the Copper River Delta, Nelson Lagoon and Point Barrow - support large concentrations of migrating shorebirds. We have accumulated information on the trophic relationships of many of the common species. And we now have a fairly complete picture of the dependence of many species on shoreline areas, particularly during post-breeding periods, to balance the more extensive information available from the breeding season. These data should allow us to predict the timing and intensity of bird use for other sites, to integrate these predictions with OCSEAP research on other trophic levels and on physical processes important to causing or dispersing oil pollution in arctic coastal areas, and, ultimately, to synthesize these diverse sets of information into predictions on how developing Alaska's petroleum resources may affect shorebird populations.

Still, Alaska's coastline is extensive and the ecological processes involved are complex. Basic distributional data continue to be needed because many areas of the Alaskan coast have been visited briefly, if at all. More information about trophic relationships is needed. And most critically, we need to examine how well patterns in use predict patterns in dependence. This will hinge upon a number of factors specific to shorebirds and oil - especially the behavioural responses of birds to oil slicks - and on issues arising in shorebird population biology as a whole, particularly the timing and mechanisms of population regulation. We lack critical understanding of the causes and effects of resource variability, both on breeding grounds, where productivity is determined, and in littoral habitats, where survival and migration success may be set. We have only the most general notions about how flexible birds are in responding to patterns in resource or environmental variability. Faced with locally depressed resources, or food made unavailable by an oil slick, will individuals respond by breeding elsewhere? Can they migrate successfully using alternate staging areas?

As we move from site-specific questions to a larger area view, our understanding decreases. What are the relationships on a community level over wide areas of the Alaskan arctic and points east and west? How are regional differences in shorebird communities related to available habitats or to migration routes? How far inland can shorebird populations be affected by coastal disturbances? How much may the success of birds nesting in Canada, Siberia or Alaska depend upon conditions in these other areas? Our knowledge of migration routes and winter areas of local arctic breeding populations of most species is very limited and generally inadequate to predict the effects of disturbances on populations elsewhere.

Have these applied studies - with practical goals in environmental management - stimulated interest in basic issues? Of course they have! Basic questions of shorebird biology have been raised or answered in all of the principal studies