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# ASPECTS OF THE WINTERING ECOLOGY OF PIPING PLOVERS IN COASTAL ALABAMA

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ABSTRACT.—Piping Plovers (*Charadrius melodus*) wintering on the Alabama coast were studied from September–October through April 1984–85 and 1985–86. Time spent foraging dominated diurnal activities during all months ($\bar{x}$ = 76%) and was highest in December (90%). Tidal height was correlated negatively with foraging time and appeared to be the most important factor influencing activities. Time spent resting and preening was related inversely to foraging, and combined time spent in agonistic, territorial, alert, and locomoting activities was <5% during all months. Piping Plovers arrived on the study area in mid-July, and several individuals remained into early April. Observations of color-marked plovers indicated that individuals were least mobile from late November through late January. Of the plovers marked in 1984–85, 63% returned during 1985–86 despite the occurrence of two major hurricanes during the fall of 1985. *Received 9 March 1987, accepted 12 Nov. 1987.*

The Piping Plover (*Charadrius melodus*) is endemic to North America, breeding locally on the upper Atlantic coast, the Great Lakes region, and the Great Plains (Johnsgard 1981). Its wintering range extends along the Atlantic and Gulf coasts from North Carolina to Mexico and into the Bahamas and West Indies (Federal Register 1985). Unregulated hunting rendered this species near extinction by 1900 (Bent 1929), but the population began to recover following protective legislation. Since 1945, however, Piping Plover populations have been declining, primarily because of alteration of breeding and wintering habitats, human-related disturbance to nesting birds, and increased nest predation (Sidle 1984).

This recent population decline prompted the U.S. Fish and Wildlife Service to list the Piping Plover as a threatened and endangered species in January 1986. The species was assigned endangered status in the Great Lakes region where the population had decreased to 20–25 pairs by 1986 (M. R. Ryan, pers. comm.); threatened status was assigned throughout the remaining range. Despite this precarious status, however, there are few detailed studies of this species, and most research addresses breeding ecology (Wilcox 1959, Cairns 1982, Faanes 1983, Haig 1985, Prindiville 1986). Investigations during winter are sparse and focus primarily on population density and distribution (Haig and Oring 1985). This lack of

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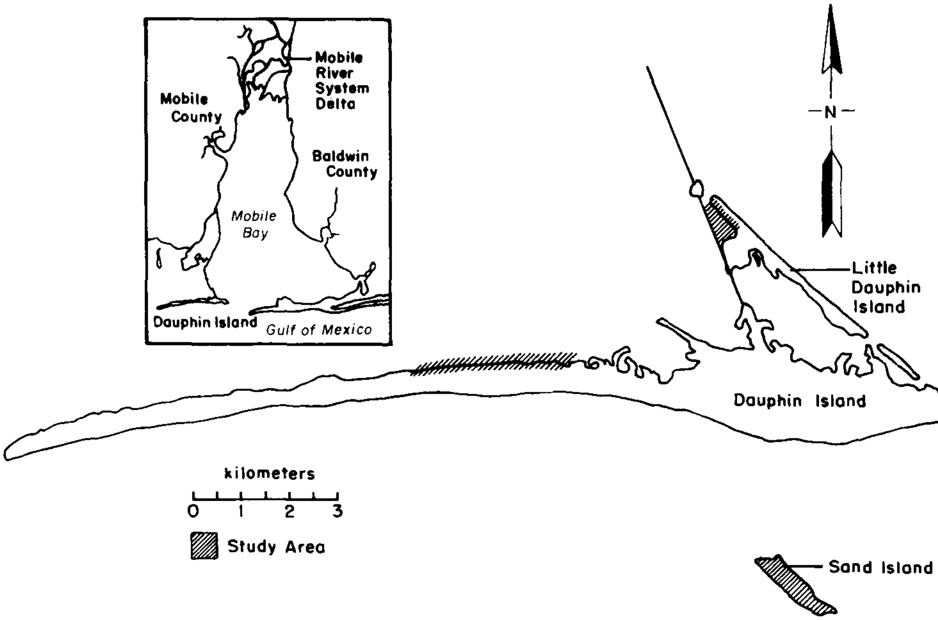


FIG. 1. Location of study sites on Dauphin Island and adjacent areas in coastal Alabama, 1984–86.

winter data is significant because substantial annual mortality in migrating shorebirds occurs away from breeding areas (Baker and Baker 1973, Evans 1981). The specific objectives of our study were to determine activity budgets, movements, and site fidelity of Piping Plovers wintering in coastal Alabama.

## STUDY AREA

Christmas Bird Count data for coastal Alabama from 1956–86 indicate that this area supports a population of wintering Piping Plovers that primarily uses only three sites: Dauphin Island, Little Dauphin Island, and Sand Island (Fig. 1). Most observations during the 1984–85 winter season were made along a 3-km beach and mudflat site on the north side of Dauphin Island because this location was the most frequently used feeding site of Piping Plovers in the area. Mudflats at Little Dauphin Island also were used for feeding by Piping Plovers, but these sites were exposed only during extremely low tides. Sand Island received use by plovers particularly after Hurricane Elena struck the area on 2 September 1985 and destroyed feeding sites on Dauphin Island and reduced availability of such sites on Little Dauphin Island. Sand Island then functioned as an alternate feeding site, thus approximately 35% of the 1985–86 time budget data were obtained from observations on Sand Island.

## METHODS

Instantaneous sampling procedures (Altmann 1974) were used to observe Piping Plovers from September 1984 through April 1985 and October 1985 through April 1986. Plovers were sampled by dividing each day (sunrise to sunset) into four equal time periods within which randomly selected individuals were observed for 5–15 min each, and their activities recorded at 15-sec intervals. Observations lasting <5 min were not considered for analysis. All observations were made using a 15–60× spotting scope and 7× binoculars, with the observer stationed at distances deemed not to affect plover behavior (30–50 m). Equal sampling during every time block of a given day was not possible at each study site because tidal fluctuations affected the number of plovers present; however, approximately 20 birds were observed per block per study site per week.

Activities were categorized as follows: (1) feeding—a peck at substrate or the extraction of a prey item; (2) running—rapid movement between a pause and feeding or two successive pauses; (3) waiting—a pause, scanning substrate before running to feed or pause again; (4) foot-tapping—tapping a foot on substrate while in waiting position; (5) foraging—the sum of feeding + waiting + foot-tapping + running, which is referred to as the "stop-run-peck" feeding method characteristic of plovers (Pienkowski 1981); (6) locomotion—running not associated with foraging, walking, or flying; (7) preening—preening, bathing, and comfort movements; (8) alert—low, crouching posture with head held erect or cocked to one side, or head-bobbing not in association with another bird; (9) territorial—parallel-run display, head-bobbing (Cairns 1982); (10) agonistic—horizontal threat displays, striking with beak or wings, and ground or aerial chases (Cairns 1982); and (11) resting—with head tucked in plumage, standing on one leg or huddled in sand (resting usually occurred on dry sand). Environmental data recorded after observation of each plover included tidal height (estimated m above low tide), cloud cover (0–25%, 26–50%, 51–75%, 76–100%), ambient wind speed (km/h), ambient temperature, and substrate temperature.

For each plover observed, the percent time spent in each activity was obtained by dividing the number of recordings in an activity by the total number of recordings for all activities. Monthly activity budgets were determined by averaging time spent in each activity per bird by each time block and then averaging time blocks by each day. Differences in activity budgets among months of each year were determined using *t*-tests and, where not significant ($P > 0.05$), years were pooled to make monthly comparisons. ANOVA and Duncan's multiple range test were used to determine significant ($P < 0.05$) differences among blocks, months, and observation sites (Steel and Torrie 1980). Pearson's correlation analysis was used to examine relationships among activities and environmental variables (Conover 1980).

Piping Plovers were banded during both years using mist nets set at approximately sunrise and sunset. Birds were weighed to the nearest g and banded with a U.S. Fish and Wildlife Service leg band and colored plastic leg bands coded for individual recognition.

## RESULTS AND DISCUSSION

*Activity budgets.*—A total of 769 observation periods of individual Piping Plovers was tallied during the 1984–85 and 1985–86 winter seasons for 100 h and 92 h, respectively. Activity patterns did not differ ($P >$

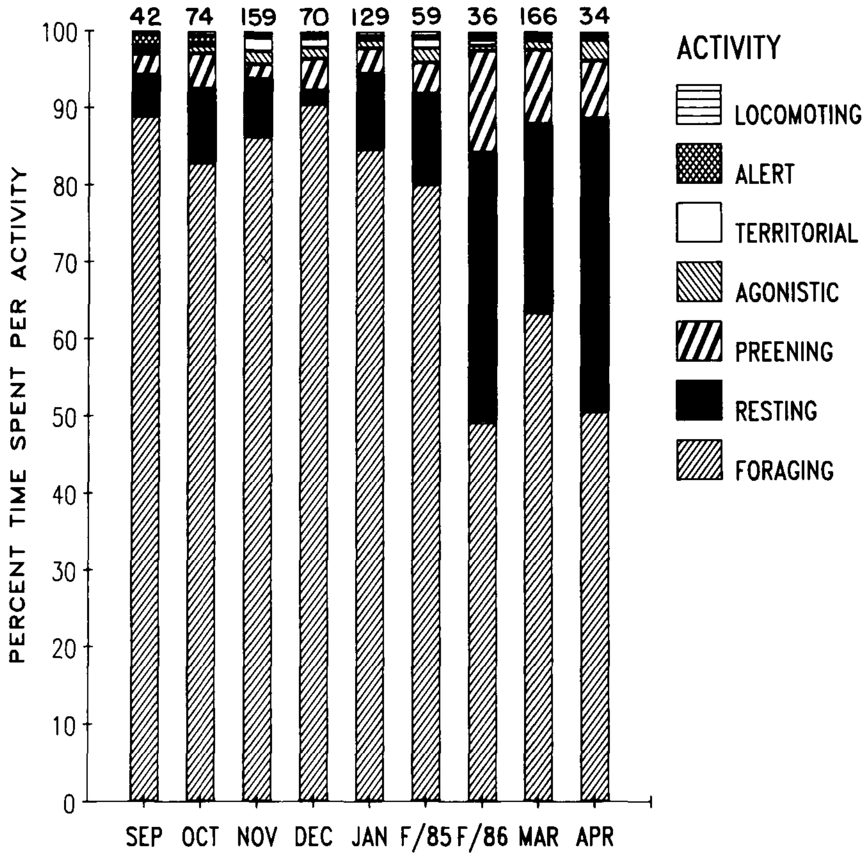


FIG. 2. Percent time spent in activities by wintering Piping Plovers in coastal Alabama during each month, 1984–86. Numbers above histograms indicate number of birds observed.

0.05) among sites or between months of different years except February. Therefore, data for all months except February were pooled across sites and years for monthly comparisons (Fig. 2).

Foraging accounted for 76% of the time spent in all activities by Piping Plovers and was greater ($P < 0.05$) during autumn and midwinter than in spring (Fig. 2). This high rate of foraging may occur because Piping Plovers are visual predators selecting surface prey items, which may restrict feeding activities to daylight hours. The greater foraging effort in autumn versus spring could reflect feeding to replenish energy reserves depleted during migration and/or accumulation of reserves in anticipation of winter weather. Many species of shorebirds wintering at mid-latitudes accumulate lipid reserves during autumn to provide an energy source for use during severe weather or temporary food shortage in winter (Dugan et al. 1981). Alternately, Piping Plovers may forage more in fall to acquire reserves to survive the severe conditions associated with hurricanes, which primarily occur along the Gulf Coast in September and October. Hurricane Elena destroyed feeding sites of Piping Plovers at Dauphin and Little Dauphin in September 1985, thus individuals accumulating lipid reserves in early autumn may survive such storms by relying on that energy to move to alternate areas or to remain in the area until habitats recover. For example, of an estimated 30 Piping Plovers in the area prior to Elena, only 5–6 were counted following the storm. High winds occurring after hurricanes also might affect feeding efforts of Piping Plovers. Dugan et al. (1981) suggested that wind strength affected the Grey (Black-bellied) Plover's (*Pluvialis squatarola*) ability to maintain weight, and thus fat reserves may insure against periods of harsh winds rather than low temperatures (Dugan et al. 1981). Strong winds also may interfere with the "stop-run-peck" feeding method of plovers by restricting the direction or speed of runs, or by reducing the visual cues of prey items (Evans 1976, Pienkowski 1983).

Plovers maintained a high foraging effort during midwinter, possibly because of higher energy requirements associated with winter conditions, even though winter is comparatively mild in the Deep South. Lower temperatures, high winds, and increased precipitation decrease activity and subsequent availability of many intertidal invertebrates at northern latitudes (Evans 1976, Davidson 1981, Pienkowski 1981). The possible effect of lower temperatures in Alabama was reflected in the greater ($P < 0.05$) time plovers spent foraging during February 1985 when mean daytime temperatures averaged 11.1°C compared to February 1986 when temperatures averaged 13.9°C. Further, all significant correlations between temperature and foraging were negative (Table 1). Pienkowski et al. (1984) found that wintering Common Ringed Plovers (*C. hiaticula*) spent more time feeding on days of lower temperatures and higher winds. In this study, correlations between foraging and wind speed also were positive where significant (Table 1).

The lower feeding time in March and April was unexpected because Piping Plovers arrive on breeding areas during these months (Wilcox 1959, Cairns 1977). Monthly censuses were not conducted during the study, but fewer birds were present in March, and most had departed by mid-April. Perhaps birds were rapidly leaving the area and/or migrants were passing through, thus lipid reserves may have been acquired earlier (January and February) and foraging efforts would be lower in March and April. Prey availability also could be more favorable during these warmer

TABLE 1

PEARSON'S CORRELATION COEFFICIENTS ($r$) BY EACH MONTH FOR SELECTED ENVIRONMENTAL VARIABLES AND FORAGING ACTIVITY OF PIPING PLOVERS WINTERING IN COASTAL ALABAMA, 1984–86

| | Environmental variables | | | | |
|---|---|---|---|---|---|
| Month | Wind (km/h) | Cloud (% cover) | Ambient temperature (°C) | Temperature at 2 cm substrate depth (°C) | Tidal height (m) |
| Sep | −0.18 (42)[a,b] | 0.18 (42) | 0.00 (42) | | −0.01 (42) |
| Oct | 0.18 (68) | −0.08 (68) | −0.17 (68) | | **−0.33 (68) |
| Nov | 0.00 (90) | 0.15 (150) | **−0.27 (109) | −0.03 (19) | −0.18 (90) |
| Dec | 0.12 (17) | 0.20 (70) | 0.08 (70) | 0.11 (53) | −0.30 (17) |
| Jan | *0.35 (54) | 0.05 (129) | ***−0.51 (129) | ***−0.43 (75) | **−0.40 (54) |
| Feb 1985 | 0.15 (59) | 0.10 (59) | *−0.29 (59) | | **−0.32 (60) |
| Feb 1986 | | 0.22 (36) | −0.24 (31) | *−0.44 (31) | |
| Mar | 0.14 (68) | 0.18 (166) | *−0.23 (112) | −0.01 (44) | ***−0.50 (68) |
| Apr | *0.45 (21) | −0.21 (34) | −0.23 (34) | *−0.61 (13) | *−0.49 (21) |

[a] Numbers in parentheses indicate sample size.
[b] * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; all other correlations were not significant.

months which would reduce foraging effort. This is supported by correlations indicating that plovers reduced foraging time when substrate temperatures were warm (Table 1).

Tidal height was correlated negatively with foraging and appeared the most important factor influencing foraging time of Piping Plovers during our study (Table 1). Rising tides gradually decrease exposed foraging space, and because tidal amplitude is small along much of the Gulf Coast, on-shore winds may delay receding tides (Evans and Dugan 1984). The substrate also dries with increasing time after exposure, and this reduces activity of intertidal invertebrates (Pienkowski 1981). Brown (unpubl.) noted that breeding Piping Plovers spent significantly more time during low tide on inner beaches with exposed muddy sandflats, but that they could be found in equal numbers on inner or outer beaches during high tides.

Haig and Oring (1985), noting that Piping Plovers used sandflats from January through March and beaches from August through October and March through May, concluded that habitat preferences were different during migration versus wintering. However, our data on substrate use (September through February, 1984–85) indicate that Piping Plovers wintering in Alabama did not exhibit these seasonal preferences. Observations of foraging Piping Plovers wintering in Alabama indicated similar use of protected mudflats or sandflats exposed at low tides; for example, foraging on dry, sandy beaches on the Gulf side of Dauphin Island accounted for only 13.3% of the time plovers were observed in that habitat. Indeed, Piping Plover use of the 6-km beach on this side of Dauphin Island was so low that the area was not considered an observation site. Plovers rather used mudflats or sandflats (both habitats were characterized by organic matter in the substrate) >85% of the time during each month ($\bar{x} = 93\%$), with no significant differences observed among months ($P > 0.10$). Plovers were seen on beaches during daylight hours in March and April, but these birds were nearly always roosting or preening. Thus, our observations indicate that sandflats, mudflats, and beaches serve different functional roles for wintering Piping Plovers. The two former sites are used for feeding, whereas sandy beaches are used for resting and probably roosting.

Combined time spent in alert, agonistic, territorial, and locomoting activities was <5% during all months (Fig. 2). Plovers were most alert during September (1.6%) and October (0.8%), possibly because migrating raptors concentrate in this region of coastal Alabama during the fall months (Imhof 1976). Human use of beaches on Dauphin Island also is high during these warm months, which could increase time spent in alert activity.

Agonistic activities were most common in April (2.6%) even though

Piping Plovers pair on the breeding grounds (Cairns 1982) and courtship displays were never observed at Dauphin Island. High rates of aggression also were observed during November and December, probably in association with territorial interactions. For example, combined time spent in territorial and agonistic activities largely involved intraspecific interactions (89%). Of all interspecific interactions (11% of the total), 29% involved Snowy Plovers (*C. alexandrinus*) and 24% involved Semipalmated Plovers (*C. semipalmatus*); 47% was in association with 6 other species.

Time spent resting and preening was related inversely to foraging activity. Preening was highest in February–April 1986, when birds were molting into breeding plumage. Locomotor activities were relatively consistent in occurrence, averaging 0.3% during all months (Fig. 2).

*Site fidelity and local movements.*—Of the color-marked plovers banded at Dauphin Island from October 1984 to February 1985, 63% (12 of 19) were recaptured or seen again the following year. This level of site fidelity was less than that of many other shorebirds returning to wintering areas (Evans 1981), possibly because two hurricanes during the fall of 1985 may have increased mortality and/or emigration to alternate wintering sites. Thus, 63% is probably a conservative estimate for Piping Plovers returning to wintering sites, but this falls within the range of estimates of return rates to breeding areas: 25% in New York (Wilcox 1959) to 75% in Manitoba (Haig 1985). The 63% return rate also can be considered a crude estimate of minimum annual survival, but the marked sample was small (19), and the proportion of juveniles to adults was unknown.

Plovers arrived on Dauphin Island in mid-July, and several individuals still were present in early April. Local movements varied among the 19 color-marked individuals during the 1984–85 winter season. For example, sightings of 9 individuals banded 1–14 November 1984 indicated that 4 stayed at least through late January 1985, whereas 4 were not seen again that season. Thus, it is difficult to determine which individuals were winter "residents," because birds may be immigrating to, or emigrating from, the area. Eleven of 17 birds (65%) marked during October and November were still present in January. Numbers of Piping Plovers seemed most stable in the Dauphin Island area from late November to late January because 82% (9 of 11) of marked birds seen from 15–30 November were seen through late January. This indicates that winter censuses might best be conducted during December and January.

Overall, the relatively high site fidelity of Piping Plovers to wintering sites in coastal Alabama indicates that conservation efforts may be warranted at specific winter sites. Protection of preferred feeding areas from development and/or other human disturbance appears especially important because plovers spend a high proportion of the winter foraging. Additionally, availability of several preferred sites within a general area may be important in limiting the effects of hurricanes or other natural disturbances on wintering Piping Plovers.

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## LITERATURE CITED

ALTMANN, J. 1974. Observational study of behavior: sampling methods. Behaviour 49: 227–267.

BAKER, M. C. AND A. E. M. BAKER. 1973. Niche relationships among six species of shorebirds on their wintering and breeding ranges. Ecol. Monog. 43:193–212.

BENT, A. C. 1929. Life histories of North American shorebirds. Pt. 2. U.S. Natl. Mus. Bull. No. 146.

CAIRNS, W. E. 1977. Breeding biology and behavior of the Piping Plover (*Charadrius melodius*) in southern Nova Scotia. M.S. thesis, Dalhousie Univ., Halifax, Nova Scotia.

———. 1982. Biology and behavior of breeding Piping Plovers. Wilson Bull. 94:531–545.

CONOVER, W. J. 1980. Practical nonparametric statistics, 2nd ed. John Wiley and Sons, New York.

DAVIDSON, N. C. 1981. Survival of shorebirds (Charadrii) during severe weather: the role of nutritional reserves. Pp. 231–250 *in* Feeding and survival strategies of estuarine organisms (N. V. Jones and W. J. Wolff, eds.). Plenum Press, New York, New York.

DUGAN, P. J., P. R. EVANS, L. R. GOODYER, AND N. C. DAVIDSON. 1981. Winter fat reserves in shorebirds: disturbance of regulated levels by severe weather conditions. Ibis 123:359–363.

EVANS, P. R. 1976. Energy balance and optimal foraging strategies in shorebirds: some implications for their distributions and movements in the non-breeding season. Ardea 64:117–139.

———. 1981. Migration and dispersal of shorebirds as a survival strategy. Pages 275–290 *in* Feeding and survival strategies of estuarine organisms (N. V. Jones and W. J. Wolff, eds.). Plenum Press, New York, New York.

——— AND P. J. DUGAN. 1984. Coastal birds: numbers in relation to food resources. Pp. 8–28 *in* Coastal waders and wildfowl in winter (P. R. Evans, J. D. Goss-Custard, and W. G. Hale, eds.). Cambridge University Press, Cambridge.

FAANES, C. A. 1983. Aspects of the nesting ecology of Least Terns and Piping Plovers in central Nebraska. Prairie Nat. 15:145–154.

FEDERAL REGISTER. 1985. Endangered and threatened wildlife and plants; determination of endangered and threatened status for the Piping Plover; final rule. 50:50726–50734.

HAIG, S. M. 1985. The status of the Piping Plover in Canada. Natl. Mus. Can., Ottawa, Ontario.

—— AND L. W. ORING. 1985. Distribution and status of the Piping Plover throughout the annual cycle. J. Field Ornith. 56:334-345.

IMHOF, T. A. 1976. Alabama birds, 2nd ed. The Univ. of Alabama Press, University, Alabama.

JOHNSGARD, P. A. 1981. The plovers, sandpipers and snipes of the world. Univ. Nebraska Press, Lincoln, Nebraska.

PIENKOWSKI, M. W. 1981. How foraging plovers cope with environmental effects on invertebrate behaviour and availability. Pp. 179–182 *in* Feeding and survival strategies of estuarine organisms (N. V. Jones and W. J. Wolff, eds.). Plenum Press, New York.

———. 1983. Changes in the foraging patterns of plovers in relation to environmental factors. Anim. Behav. 31:244–264.

———, P. N. FERNS, N. C. DAVIDSON, AND D. H. WORRALL. 1984. Balancing the budget: measuring the intake and requirements of shorebirds in the field. Pp. 29–56 *in* Coastal waders and wildfowl in winter (P. R. Evans, J. D. Goss-Custard, and W. G. Hale, eds.). Cambridge University Press, Cambridge.

PRINDIVILLE, E. M. 1986. Habitat selection and productivity of Piping Plovers in central North Dakota. M.S. thesis, Univ. Missouri, Columbia, Missouri.

SIDLE, J. G. 1984. Piping Plover proposed as an endangered and threatened species. U.S. Fish and Wildlife Service, Federal Register 49:44712–44715.

STEEL, R. G. D. AND J. H. TORRIE. 1980. Principles and procedures of statistics, 2nd ed. McGraw Hill Book Co., New York, New York.

WILCOX, L. E. 1959. A twenty year banding study of the Piping Plover. Auk 76:129–152.