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Effects of human activity on the foraging behavior of sanderlings *Calidris alba*

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Abstract

Urbanization and coastal development has dramatically reduced the beach habitat available for foraging shorebirds worldwide. This study tested the general hypothesis that recreational use of shorebird foraging areas adversely affects the foraging behavior of sanderlings *Calidris alba*. Observations conducted on two central California beaches from January through May and September through December of 1999 showed that number and activity of people significantly reduced the amount of time sanderlings spent foraging. Although the sample size was low, the most significant negative factor was the presence of free running dogs on the beach. The experimentally determined minimal approach distance did not vary significantly with the type of human activities tested. Based on these results, policy recommendations for minimizing the impact of human beach activities on foraging shorebirds include: (1) people maintain a minimum distance of 30 m from areas where shorebirds concentrate and (2) strict enforcement of leash laws.

Keywords: Sanderlings *Calidris alba*; Human disturbance; Minimal approach distance; Shorebird foraging behavior; Monterey California

1. Introduction

Bird populations have been decreasing due to competition with humans in habitats that are vital to the bird's survival. Oil spills and loss of nesting habitats have adversely affected shorebird populations such as sanderlings *Calidris alba*, semipalmated plovers *Charadrius semipalmatus* (Burger, 1997), and piping plovers *Charadrius melodus* (Burger, 1987). Populations of sanderlings, whimbrels *Numenius phaeopus*, dowitchers *Limnodromus* sp., and snowy plovers *Charadrius alexandrinus* have been decreasing since 1972 (Howe et al., 1989) primarily due to the loss of their primary habitat.

As human coastal populations increase, so does the potential for shorebird disturbance. Burger (1993) found that in areas of limited human activity shorebirds devote nearly 70% of their time foraging and 30% of their time avoiding people or predators; however, when the population of people increased, shorebirds foraged less than 40% of their time. With decreased food consumption and increased energy expenditure as birds avoid humans, compensation for this disturbance must be found elsewhere or at some other time. Vines (1992) reported that oystercatchers *Haematopus palliatus* shifted their foraging and nesting activities to offshore islands in response to an increase in people on the beaches in Florida. Burger and Gochfeld (1991) found sanderlings not only concentrated their foraging activities in areas with fewer people but also increased time spent foraging nocturnally. While other shorebirds, like the piping plover, concentrate their foraging in areas with the least amount of people within a particular habitat (Burger, 1994).

Here we sought to determine which types of common human beach activities in central California are most disruptive to shorebird foraging behavior. Our purpose was to determine how humans might modify their beach behavior so as to reduce the disturbance to foraging shorebirds. The following hypotheses were tested: (1) human activity has an adverse affect on the forging behavior of sanderlings, but (2) fast and group human activities have a greater negative affect on sanderling foraging behavior than slow or individual activities.

The general approach used focal observations of individual sanderlings foraging on public beaches to

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document their response to various types of human activities. Additionally, a minimal approach distance experiment was conducted to determine the distance a person or group of people could get to a sanderling before the sanderling stopped foraging. These results were then used to propose policy recommendations for modifying human behaviors to reduce the impact on shorebird foraging.

2. Methods

2.1. Sites

This study was conducted on two beaches on Monterey Bay in central California (Fig. 1). Monterey State Beach (Seaside Unit) in Seaside, CA has a large human population during the week, which increases significantly on the weekend. Moss Landing State Beach in Moss Landing, CA is characterized by a low population of people throughout the week. Both beaches are long linear sandy habitats, backed by sand dunes, where sanderlings foraging primarily on the common mole crab *Emerita analoga*.

2.2. Observations

Foraging observations were made at both sites January through May and September through December of 1999, corresponding with spring and fall shorebird migration. Paired weekday and weekend days (Friday/Saturday or Sunday/Monday) were selected during the same week to avoid tidal variations within a sampling period. Each observation period lasted 3 h, starting a half-hour before low tide, corresponding with the prime foraging time of sanderlings.

Sampling methodology was based on work done by Burger and Gochfeld (1991). At the start of each observation period, the following data were collected: date, day, time of low tide, level of low tide, number of sanderlings on the beach, number of people on the beach, and number and species of other birds on the beach. Individual sanderlings were haphazardly chosen from among individuals foraging within the swash zone, and the following information recorded over a 1-min sampling period:

- amount of time the sanderling foraged,
- amount of time the sanderling was disturbed by people,
- number of times the sanderling moved due to human disturbance,
- response of the sanderling due to disturbance (running or flying),
- estimation of distance the sanderling moved due to human disturbance,
- number of people causing the disturbance,
- type of activity people were engaged in when disturbance occurred; and
- estimation of distance from bird to person(s) at the time of disturbance.

Data for focal individuals were discarded if the bird flew out of view or moved into the dunes. No attempt was made to quantify prey abundance.

Before the observations were conducted, observers were tested for accuracy in estimating distances. Observers were asked to estimate previously measured distances numerous times to assure estimates were similar to real distances.

An ANOVA was used to determine if the variables day, site, number of people, people activity, and distance of people had a significant effect on the foraging time, number of sanderling moves, the distance the sanderling moved, and the behavioral response (flying or running).

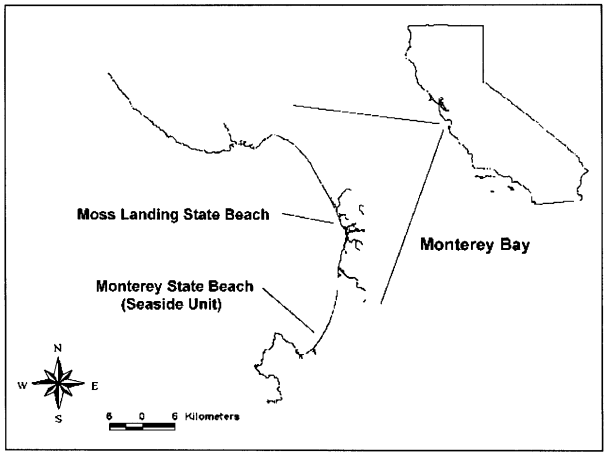

Fig. 1. Locations of Moss Landing State Beach and Monterey State Beach (Seaside Unit) on Monterey Bay in central California.

2.3. Minimal approach distance

A minimal approach distance experiment, based on methods used by Roberts and Evans (1993), was conducted to determine how close a single person or group of people could get to a foraging sanderling before the foraging behavior changed.

To determine the minimal approach distance, a sanderling was haphazardly chosen from the flock by an observer. Once an individual was identified, an "intruder" approached the flock without knowing which sanderling the observer was watching. When the observer noticed a change in the foraging behavior of the sanderling the "intruder" was told to stop. The distance was then measured from where the "intruder" stopped to the sanderling's last foraging position. Communication between observer and "intruder" was conducted

via radio headsets to limit the effects of vocalizations on foraging sanderlings. Two human activities were tested, walking and running, with one and two people acting as "intruders". Each experiment was conducted a minimum of 58 times.

3. Results

3.1. Observations

A total of 492 focal birds were observed, of which a sanderling was disturbed by passing humans on an average of one every 15 min with 96% of those sanderlings responding to humans at a distance of 30 m or less (Fig. 2). Sanderlings responded to human activity by either running (42%) or flying (58%). Within the 1-min sampling time, the disturbed sanderling generally moved once (58%), with 42% moving more than once due to human disturbance.

Five different human activities were observed on the two beaches, although not all activities occurred on both beaches. Walking was the most common activity (53%), followed by running (28%) and stationary activities (9%). On two separate occasions a person was observed throwing an object at a flock of sanderlings, and on one occasion a wind powered three-wheeled vehicle (kite buggy) was observed interfering with sanderling foraging. However, there were six separate observation periods where these high-speed, kite buggies were observed at Monterey State Beach (Seaside Unit) and there were no shorebirds present during the time these vehicles were in use.

Overall, sanderlings spent 98% of the time foraging and 2% of their time avoiding human interaction. Although not statistically significant, when looking at Moss Landing State Beach and Monterey State Beach (Seaside Unit) separately, it was found that sanderlings spent more time foraging when there were fewer people, 99.8 and 96.4%, respectively.

Results indicate that number of people, type of human activity, and free running dogs had a significant (ANOVA, $P = \ll 0.001$) effect on foraging time ($n = 449$; $F = 14$; Table 1). Number of people, type of human activity, free running dogs, and estimated distance of humans from the sanderling had significant effects on estimated distance the sanderling moved ($n = 488$; $F = 275$), number of times the sanderling moved ($n = 488$; $F = 85$), and response of the sanderling (running or flying; $n = 488$, $F = 203$) to the approaching human. Day of the week and combination of site and day showed no significant difference on foraging time.

3.2. Minimal approach distance

The minimal approach distance was used to test the hypothesis that sanderlings have a higher tolerance for certain types of human activities. A total of 242 experiments were conducted testing sanderling responses to one person walking ($n = 61$), one person running ($n = 60$), two people walking ($n = 63$), and two people running ($n = 58$) with 100% of the sanderlings responding to people within 3–26 m (Fig. 2).

Results indicate a statistically significant difference on how close people could get to foraging sanderling based on the number of people in the group ($z = 1.93$). However, the type of activity people were engaged in (running or walking) was not statistically significant ($z = 0.74$, Fig. 3).

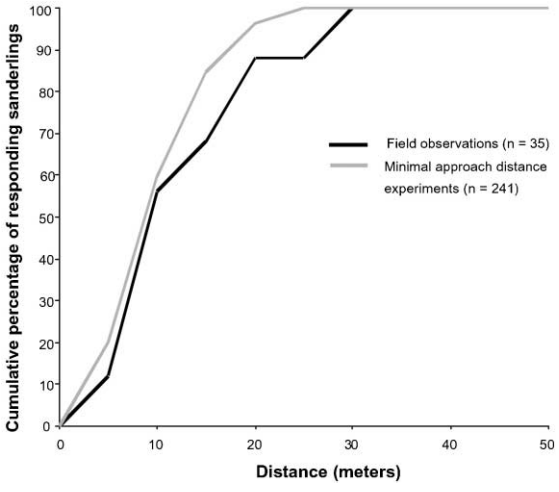

Fig. 2. Field observations show 100% of sanderlings responding to humans reacted when people were 30 m or closer. Sanderlings tested in the minimal approach distance experiment reacted to approaching humans at a distance of 26 m or less.

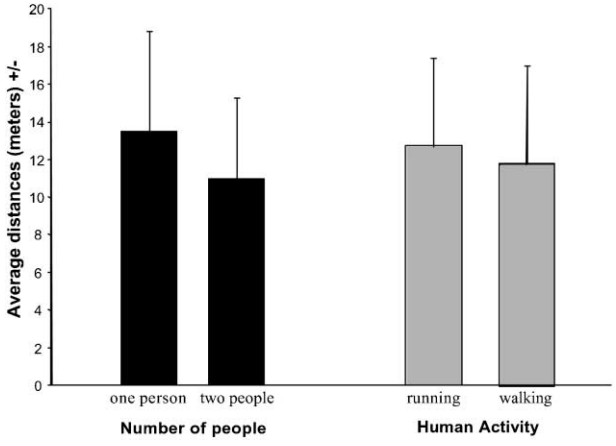

Fig. 3. Results from minimal approach distance: there is a statistically significant difference in how close a person or group of people can get to a foraging sanderling before the sanderling changes behavior ($z = 1.93$). However there was no statistical difference in the type of activity humans were engaged in while approaching foraging sanderling ($z = 0.74$).

Table 1
ANOVA results from focal observations: The *P* values for human disturbance on sanderling responses, shows that the activity and number of people and presents dogs significantly reduces the amount of time sanderlings spend foraging

	Foraging	Number of moves	Distance moved	Sanderling movement
Site	0.398	0.757	0.815	0.905
Day of week	0.551	0.630	0.594	0.547
Site/day of week	0.319	0.532	0.359	0.294
Activity of people	≪0.0001	≪0.0001	≪0.0001	≪0.0001
Distance of people	0.488	≪0.0001	≪0.0001	≪0.0001
Number of people	≪0.0001	≪0.0001	≪0.0001	≪0.0001
Dogs	≪0.0001	0.002	≪0.0001	≪0.0001

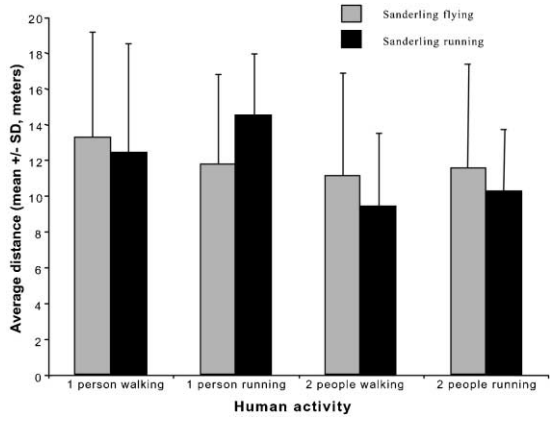

Fig. 4. Results from minimal approach distance: the graph shows the average minimum distance that human "intruders" could approach sanderlings before the bird changed their foraging behavior. Statistically significant differences occurred between one person running and two people walking towards the sanderling causing the sanderling to respond by running ($z = 1.91$), and between one person and two people running resulting in the sanderling taking to flight.

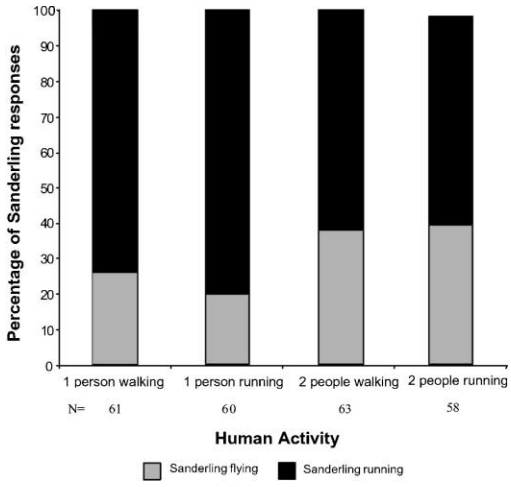

Fig. 5. Results from minimal approach distance: the majority of sanderlings responding to human "intruders" did so by running, although not statistically significant two people approaching the sanderling (regardless of the activity) caused more sanderlings to fly.

The average minimal approach distance for all activities combined was 14 m (±5.0). The only statistically significant differences occurred between one person running and two people walking towards the sanderling causing the sanderling to respond by running ($z = 1.9$), and between one person and two people running causing the sanderling to fly ($z = 1.91$, Fig. 4). Sanderlings typically responded to human "intruders" by running (69%) no matter the activity or number of people involved (Fig. 5).

4. Discussion and policy recommendations

Field observations indicate that number of people, type of activity, free running dogs and proximity of people can significantly reduce the time that sanderlings spend consuming prey. These four variables also had a statistically significant effect on the distances sanderlings moved and the type of response that the sanderling had to the approaching humans.

Results from the minimal approach distance indicate that number of people can significantly reduce the amount of time that sanderlings spend foraging. Activity of the person or group of people was not a significant factor in the reduction of foraging time. Regardless of the number of people or speed of their approach, the average minimum approach distance was statistically the same (14 m) for each of the tested activities, with the exception of two people running compared to two people walking, causing the sanderling to run, and two people running compared to one person running resulting in the sanderling taking to flight. Although not statistically significant, as the number of people approaching the sanderling increased so did the number of times the sanderling took to flight.

These results suggest that the impact of humans and their pets on shorebird foraging, although considerable, can be significantly reduced by implementing three simple policies governing human beach behavior. First, based on the minimal approach distance experiment and

field observation results showing 100% of sanderlings responding to humans within 30 m, people should be encouraged to stay a minimum of 30 m away from concentrations of shorebirds. Second, leash laws should be strictly enforced at primary bird foraging sites. At both of the study sites, as well as all state parks, leash laws exist, however the majority of people still let their dogs run free.

Third, the fact that there were no shorebirds observed on the beach when kite buggies were present suggests that birds are entirely excluded by this activity. These vehicles can travel at speeds which allow them to cover a large distance of beach in a very short period of time. As a result of this observation, we recommend that these vehicles are restricted to a certain portion of the beach and prohibited during peak migration season. Activities like the use of kite buggies should, in the future, be included in the minimal approach distance experiments so that the extent to which shorebirds are affected can be determined.

The above policies, encouraging modest changes to human beach behavior would enable people to enjoy most of their favorite beach activities while allowing shorebirds to spend more time foraging and less time avoiding humans in habitats so critical to their survival.

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