Recreation Disturbance Does Not Change Feeding Behavior of the Western Snowy Plover

Megan Warren

Abstract The Western Snowy Plover (*Charadrius alexandrinus nivosus*) is a small shorebird that has many scattered wintering populations along the Pacific Coast of the United States, including several in the Bay Area. This species has been listed as threatened since 1993 under the federal Endangered Species Act of 1973. For this study I measured disturbance rates, types, plover responses and feeding time in three different sites in the San Francisco Bay Area to explore the link between recreation disturbance and feeding behavior. I predicted that as frequency of disturbance increased, the birds would spend less time actively foraging and more time alert. However, data showed no significant relationship between feeding behavior and direct disturbance by human recreators. Instead, I now predict that recreation has a more indirect effect on the western snowy plover feeding behavior. Future research should focus on indirect effects of recreation, such as habitat disturbance and food source quality.

Introduction

Outdoor recreation has increased in popularity over the years, resulting in expansion and development of designated outdoor recreation areas (Flather and Cordell 1995). Non-motorized recreation, such as hiking, nature viewing, horseback riding, beach bathing and dog-walking have increased the most in popularity (Flather and Cordell 1995). As these activities become more popular, they often disturb and displace wildlife populations, causing them to change specific behaviors and habits. Once-popular breeding sites located in popular recreation areas may be abandoned for less hospitable sites simply due to the amount of disturbance (Knight and Cole 1995).

Shorebirds are especially vulnerable to recreation, which can disrupt available habitat for nesting and foraging (Burger 1995). Recreation can be especially harmful for species already struggling to make a living in a specific area. One such species is the western snowy plover, a small shorebird found along the Pacific Coast. This species has been listed as threatened since 1993 under the Endangered Species Act of 1973 (Smith 1993). Ruhlen et al. (2003) found that on average, more snowy plover (*Charadrius alexandrinus*) chicks died or wandered away on weekends at two beaches in the Point Reyes National Seashore, possibly due to increased recreation on those days. Many other studies on plover species (*C. alexandrinus, C. melodus*) have shown that human disturbance leads to changes in habitat use and foraging—both when and how long birds forage, as well as decreased nest success (Lafferty 2001b, Burger 1991, Burger 1994, Lafferty et al. 2006).

Foraging success is a good indicator of nesting success. Shorebirds with habitats more prone to high levels of disturbance spend more time fleeing from and watching for potential predators, depleting fat reserves and time spent caring for their broods (Burger 1991). The western snowy plover forages for both marine and terrestrial invertebrates by visually scanning then probing with its beak in the sand, washed-up seaweed, and low vegetation. Western snowy plover are often found foraging together in small groups (Page et al. 1995). Newly-hatched chicks are precocial, and can walk around and forage for themselves shortly after hatching (Tucker and Powell 1999). Recreational use of plover foraging areas is especially harmful to these newly-hatched chicks (Ruhlen et al. 2003). This study addresses how recreation affects wintering populations of the western snowy plover by examining its feeding behavior at several more

heavily used sites in the San Francisco Bay Area, where the relationship between shorebird feeding behavior and recreation has yet to be fully explored.

Since its inception in 1972, the Golden Gate National Recreation Area (GGNRA) has become one of the most popular and heavily used urban national parks, with more than 10 million visitors per year (NPS 2006). Even before the formation of the park the area was heavily used by recreationists. Many locations within the park are prime breeding habitat for the threatened sub-species western snowy plover (*Charadrius alexandrinus nivosus*), but within the park only wintering populations can be found (Merkle 2006, pers. comm.). Western snowy plover stopped breeding on the beaches in the GGNRA, most likely due to an increase in disturbances from recreation. One of the largest disturbances to western snowy plover, as well as other shorebirds, is dog-walking, especially those off-leash (Lafferty 2001a). In 2002 GGNRA began considering changes to its dog policy. Currently, off-leash pets are allowed in many areas of the park including those important to the western snowy plover—Crissy Field and Ocean Beach (US Department of the Interior 1979). An advisory committee was formed to take place in the negotiated rulemaking, which encompasses the many interest groups with stakes in the rule changes (NPS 2006). Changes in these policies could positively impact populations of the western snowy plover currently wintering in GGNRA, and is important to understand how recreation affects all matters of their biology before making any permanent changes.

It is also important to understand what kinds of disturbances adversely affect foraging behavior. Determining these and other answers are important when deciding how western snowy plover habitat, such as that in GGNRA, should be managed in the future. The main objective of this study is to see how recreation and direct disturbance impacts western snowy plover feeding behavior, which can then be used to create appropriate wildlife management plans. I predict that western snowy plover populations in more heavily-disturbed areas will devote more of their feeding time towards avoiding disturbances than to actively searching for and eating their food.

Methods

For this study, two different kinds of direct observational surveys were developed and carried out weekly for five weeks at three different study sites during February and March 2007.

Study Sites Three study sites were used in this research. The first study site was at Crissy Field in San Francisco, California, which is part of the Golden Gate National Recreation Area

(Fig. 1). The stretch of beach where the western snowy plover is found is 100 meters east of the Gulf of the Farallones Visitors' Center (Fig. 2). The beach is 80 meters long and its habitat is characterized by sand dunes with low vegetation. This site supports a population of four to six birds. Crissy Field is readily accessible by car, foot, bike and public transit. This site has also recently (October 2006) changed from an off-leash to on-leash dog area. For this study, Crissy Field was classified as a high-use recreational site. The second study site was the spit at Limantour Beach in the Point Reyes National Seashore (PRNS), located about 56 kilometers north of San Francisco in Marin County, California (Fig. 3).

Figure 1: Golden Gate National Recreation Area, California

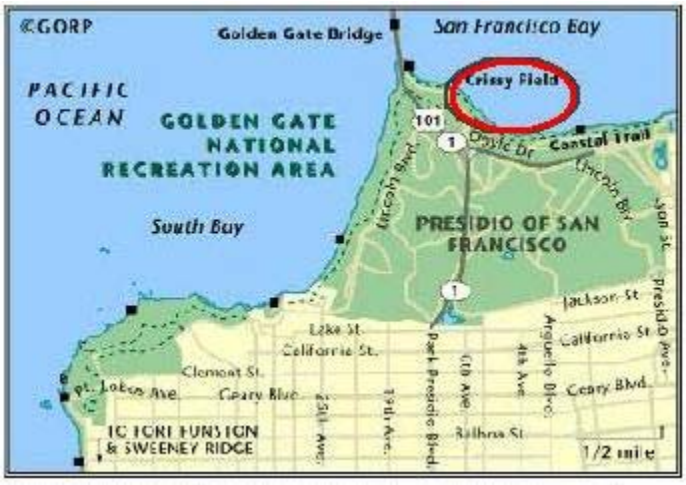

Figure 2: Crissy Field Study Site, in Golden Gate National Recreation Area, CA

Figure 3: Limantour Beach and Abbott's Lagoon Study Sites, Point Reyes National Seashore, CA

Limantour Spit juts into Drake's Bay and is about four kilometers long, and is characterized by long stretches of beach with little vegetative cover. This site supports a population of 80-100 birds. Limantour Beach is relatively busy, as it is accessible just off a main road near the entrance of PRNS. Any type of recreation is permitted; however, dogs are restricted to the area of the beach away from the plovers. Limantour Beach was classified as a medium-use recreational site. The third study site was also located in the Point Reyes National Seashore at Abbott's Lagoon, which is 16 kilometers

northwest of Limantour Spit on the Pacific Ocean (Fig. 3). Abbott's Lagoon is characterized by low sand dunes with little vegetation, and supports a population of 45-50 birds on a two kilometer stretch of beach at the foot of the lagoon. This site is the most isolated and least accessible of the three sites, and was classified as a low-use recreational site.

Disturbance Surveys Disturbance surveys were conducted over a one-hour period just before dusk at each study site. The minimum population size for each survey sample period was four birds. Upon locating the population, date, time of day, general weather patterns and study site were noted at the top of the data sheet. For each instance of disturbance (defined as a recreational activity that could change behavior of the western snowy plover), time, type (individual or group), activity, distance from birds, number of birds disturbed and their response was recorded. The birds' responses were divided into four categories: no response, mild response (causing a resting plover to stand), moderate response (causing a plover to stand up and/or walk away), and major response (causing the plover to flush). The data gathered from these studies were used to create graphs showing frequency of certain types of recreation at each site.

Feeding Behavior Surveys Feeding behavior surveys quantified how the plovers budgeted their time during the dusk feeding period. The purpose of these surveys was to observe the percent breakdown of the plover behavior (based on time) and link behavioral changes to nearby recreational disturbances. Over the 30 minutes following the recreation disturbance surveys four different focus-animal surveys were carried out, each time on a different bird. Focus animal surveys were two minutes long. An Olympus digital voice recorder, model VN-3100, was used to measure the total amount of time the bird spent in each of three feeding behaviors. These behaviors were observed and defined during preliminary observation periods. The western snowy plover was seen (1) searching for food, defined as movement along the shoreline with its head down visually scanning for prey; (2) actively foraging, defined as head down with its beak in the sand eating the prey; and (3) time spent alert, defined as a bird standing still with its head up visually scanning the beach. Once transferred to the computer, the recorder shows exactly how many seconds were spent on each activity. A linear regression was used to test the relationship between frequency of disturbance and foraging, alert and searching time.

Results

Recreation and foraging data were collected at the Abbott's Lagoon, Limantour Beach and Crissy Field study sites over four observation days on a Thursday, Friday or Saturday between February 1, 2007 and March 8, 2007. Western snowy plover do not feed at Crissy Field, so data on recreation disturbance and feeding behavior comes from the two Point Reyes National Seashore sites.

Recreational Use Accessibility is the main factor distinguishing recreational use among the three beaches. Not surprisingly, the urban study site, Crissy Field, showed the highest and most varied recreational use of all the sites (Fig. 4). Limantour Beach, the next most accessible site had the second highest recreational use, though only walkers used the site. Finally, Abbott's Lagoon, the most isolated of the three sites, had the lowest recreational use. Again, this site was only frequented by walkers. Both PRNS sites were comparable in terms of type of recreation and foraging data.

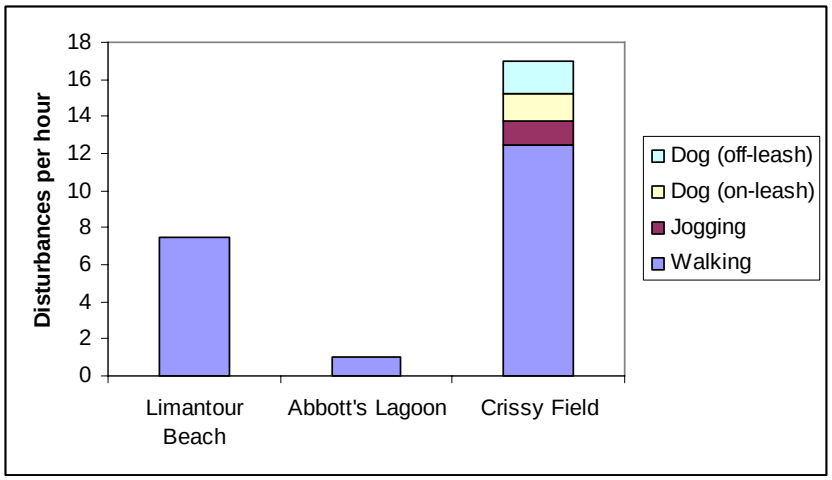

Figure 4: Recreation level and type per hour at each study site

Disturbance Data The disturbance surveys were used to determine two things. First, they were used to see how strongly resting birds responded in the presence of human recreators. Secondly, they were used in conjunction with feeding behavior surveys to infer changes in foraging, searching and alert time based on how heavily the site was used. Protocol dictated that western snowy plover response to recreators be classified as mild, causing a resting bird to stand; moderate, causing a resting bird to stand and walk away; or major, causing a resting bird to flush. The first part of the disturbance surveys showed by and large that resting plovers do not react strongly to the presence of recreators (Table 1). Since feeding behavior was not observed during any of the observation periods at Crissy Field, useful data came only from Limantour Beach and Abbott's Lagoon. A linear regression with these data shows no relationship between disturbance level and foraging time (Fig 5) (R^2=0.0011, p=0.86). Similarly, no relationship exists between

disturbance level and alert time (Fig 6) (R^2=0.0039, p=0.73). A slightly stronger positive linear relationship is found between disturbance level and searching time (Fig 7) (R^2=0.046, p=0.24); however, this is still an incredibly weak relationship, and cannot be considered significant.

Table 1: Proportion of plover mild, moderate or major response to recreation, by site

		% Plover Response to Recreation				
		None	Mild	Moderate	Major	Sample Size
Crissy Field						190
	Walking	45	9	7	0	
	Jogging	10	2	0	0	
	Dog (off-leash)	7	3	6	0	
	Dog (on-leash)	6	3	2	0	
Limantour Beach						81
	Walking	59	11	15	15	
Abbott's Lagoon						8
	Walking	25	37.5	37.5	0	

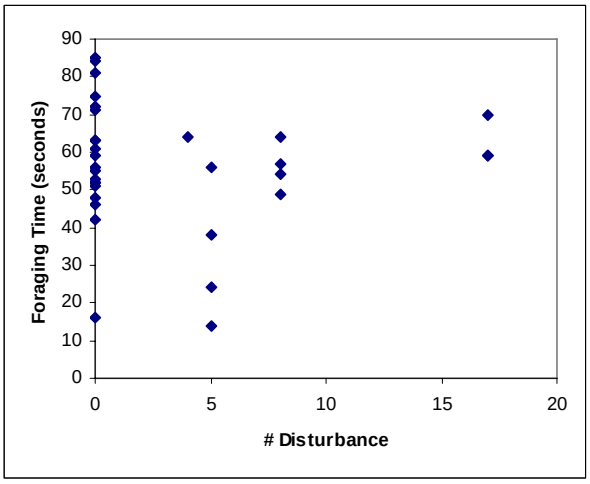

Figure 6: Disturbance level vs. alert time

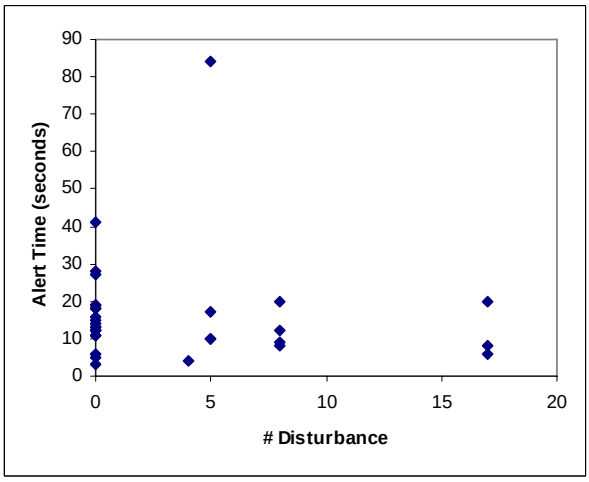

Figure 5: Disturbance level vs. foraging time

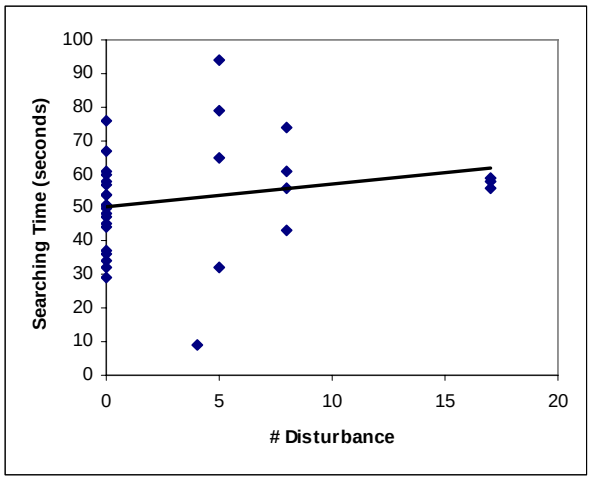

Figure 7: Disturbance level vs. searching time

Feeding Behavior Data Crissy Field is the only site at which the birds were not found foraging in the evening, and they are not always at the site. Of six survey dates, they were only on the beach for four of them, and not once were they foraging. When the birds are at this site, they begin to get restless around 5:45 p.m. and soon fly away, presumably to go forage in a different area. Data from Limantour Beach and Abbott's Lagoon suggest that no significant relationship exists between disturbance level and foraging behavior. Therefore, it can be assumed that the absence of foraging western snowy plover at Crissy Field is due to other factors, such as quality of the food source available at the site.

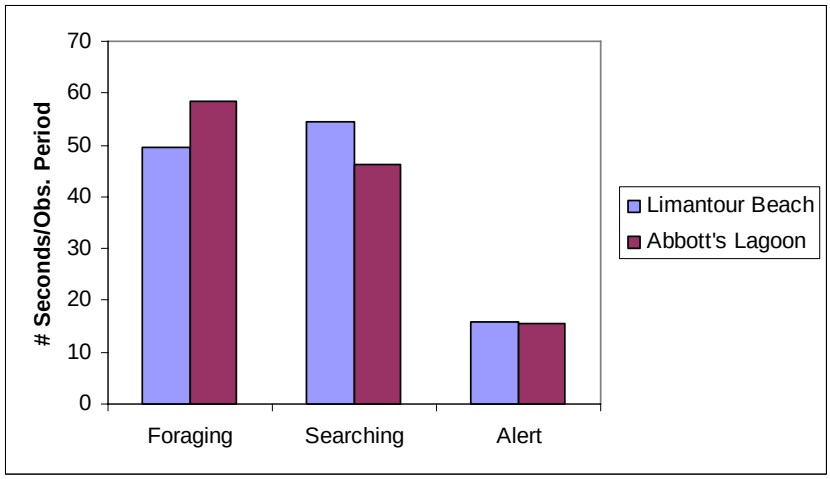

Figure 8: Average distribution of three feeding behaviors by over 2-minute focus-animal surveys

Average times for the three observed feeding behaviors are consistent between the Abbott's Lagoon and Limantour Beach data (Fig. 8), which also suggests no relationship between disturbance level and feeding behavior. Limantour Beach was a site with medium disturbance levels, and Abbott's Lagoon

was a site with low disturbance levels. Both sites had between 10 and 20 birds on each observation day.

Discussion

This study looked at links between disturbance level and foraging behavior of the western snowy plover at three different beaches in the San Francisco Bay Area. The Crissy Field study site did not provide any relevant results, however, the data from the two Point Reyes study sites do not support the hypothesis that western snowy plovers in more heavily disturbed areas devote less time to actively foraging and more time to being alert.

Data show no significant correlation between number of disturbances and time spent actively searching or foraging, or being alert while feeding at dusk. These results suggest that direct recreation disturbance is not as significant as earlier thought, and that links between recreation and western snowy plover feeding behavior are more subtle. Several possible explanations exist for explaining these relationships. The data suggest that as more disturbances occur, more time is spent on searching than on being alert or foraging. Though not significant, this relationship does bring to mind other possible explanations of the trend indirectly related to recreational use at certain sites.

Accessibility and disturbance are two possible explanations for increased searching time at more heavily used sites. At Limantour Beach, recreational use tends to be right at the shoreline, which is also where the western snowy plover forage. With an overall higher recreation use than Abbott's Lagoon, Limantour Beach may have a more disturbed habitat at the shoreline, which could make less overall food available, or just make it harder to find. Another explanation could be absence of biological debris, such as seaweed, kelp, and dead or decaying sea birds and mammals. Since Limantour Beach is used by more people, biological debris is either displaced or removed. This debris has been proven to be an important food source for shorebird communities in southern California (Dugan et al. 2003), and its removal could force the western snowy plover to spend more time searching for food along the disturbed shoreline. Finally, poor food source quality has been linked with failed hatching of western snowy plover eggs due to high mercury levels at Point Reyes Beach (Schwarzbach et al. 2005). Pollution may be an indirect result of recreation that may cause western snowy plover to spend more time seeking out

suitable food. Quality of the food source itself is very important for the continued success of this species.

The western snowy plover is affected by recreation, albeit indirectly (such as with shoreline disturbance). Future studies should focus on both the quality of the food source and the habitat disturbance at important breeding and wintering sites for the western snowy plover. More vigorous methods should also be developed for monitoring feeding behavior in order to take into account not only the time spent doing each activity, but also where the western snowy plover choose to forage, and what they choose to eat. Studies should also focus on the relative disturbance of foraging habitats. A more careful selection of study sites must take place. It is important to find habitats with varying levels of recreation and habitat disturbance where the birds are known to spend time feeding. Though this study had a range of disturbance levels at each site, feeding habitat was not suitable at Crissy Field and therefore not observed. Furthermore, the data from Limantour Beach and Abbott's Lagoon showed extremely weak to non-existent correlations that cannot be extended to Crissy Field. It is important to keep monitoring western snowy plover populations to detect any changes in their behavior (foraging or otherwise).

This research project is perhaps more useful as an education tool. If anything, increased monitoring of bird populations will make people more aware of their presence. The snowy plovers can be difficult to see, but are really interesting to watch. If recreationists are aware of their presence, they can conduct their activities in a way that still allows them to have fun, but to decrease their affect on wintering populations of the western snowy plover.

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