Management and Conservation Article

Foraging Shorebird Response to Trail Use Around San Francisco Bay

LYNNE A. TRULIO,[1] *Department of Environmental Studies, San Jose State University, One Washington Square, San Jose, CA 95192-0115, USA*

JANA SOKALE, *7788 Hazelnut Drive, Newark, CA 94560-2234, USA*

ABSTRACT We studied how human use of trails affected foraging shorebirds over 24 months at 3 locations around San Francisco Bay, California, USA. By observing sites with trails and nearby sites without trails, we assessed whether numbers of trail users had an effect on the number of birds, species richness, or proportion of shorebirds foraging on tidal mudflats. Human use at non-trail sites averaged <1 person/hour, whereas use at trail sites averaged 68 people/hour. Despite these differences, we found no negative effects of trail use on the number of birds, species richness, or proportion of birds foraging, either overall or by season, when comparing trail to non-trail sites. Human use of trail sites on higher use days (typically weekends) averaged about 2.5 times the level on lower use days (typically weekdays). When comparing bird response on paired lower and higher use days at the trail sites, we found the number of shorebirds decreased with increasing trail use ($F_{1,119} = 4.20$, $P = 0.043$), with higher trail-use days averaging 25% fewer birds than on lower use days. Although managers may allow human use of trails adjacent to shorebird foraging areas under some conditions, high levels of trail use may negatively affect birds, making it essential to offer birds alternative, trail-free foraging opportunities. (JOURNAL OF WILDLIFE MANAGEMENT 72(8):1775–1780; 2008)

DOI: 10.2193/2007-014

KEY WORDS behavior, bird numbers, ecotourism, foraging, human disturbance, recreation, San Francisco Bay, shorebirds, species richness, trails.

Recreation, including ecotourism in which people travel to view species (Burger et al. 1995), has the potential to negatively affect bird populations, especially in areas where birds congregate (Klein et al. 1995, Burger 2000, Bouton et al. 2005). Understanding impacts of human activity on shorebirds at migratory stopover sites where thousands of birds congregate is especially important because stopover sites are essential for successful migration and overwintering (Bishop and Warnock 1998, Page et al. 1999). Migratory sites can be attractive to tourists and recreationists for wildlife viewing (Klein et al. 1995, Burger 2000), particularly when located near densely populated, urban areas where public access is popular. The effect of human presence on shorebirds at migratory stopover sites has been studied on the east coast of the United States (Burger 1981, Pfister et al. 1992, Burger et al. 1995, Klein et al. 1995, Burger and Gochfeld 1998), in British Columbia (Yasue 2005, 2006), and in England (Gill et al. 2001*a*, Burton et al. 2002), but not along the Pacific Flyway in the San Francisco Bay, California, USA.

San Francisco Bay is one of only a few sites in the world where >1 million migratory shorebirds stop or overwinter (Bishop and Warnock 1998, Page et al. 1999). This estuary provides seasonal habitat for >50% the Pacific Flyway population of numerous migratory shorebird species, including least (*Calidris minutilla*) and western sandpipers (*C. mauri*), short- (*Limnodromus griseus*) and long-billed dowitchers (*L. scolopaceus*), and marbled godwits (*Limosa fedoa*), as well as resident American avocets (*Recurvirostra americana*) and black-necked stilts (*Himantopus mexicanus*; Page et al. 1999). In addition to being a critical migratory bird site, the San Francisco estuary is surrounded by >7 million people who look to the Bay as a recreational resource and it is one of the most popular tourist destinations in the world (U.S. Department of Commerce 2005). Hundreds of miles of trails exist adjacent to the Bay and many more are planned (Fig. 1), but few studies have specifically examined the effect of trail use on shorebirds (Burger 1981, Klein 1993, Gill et al. 2001*a*, Burton et al. 2002) and none in the San Francisco Bay area.

Our objective was to assess the relationship between numbers of trail users, overall and by season, on numbers of shorebirds, species richness, and proportion of birds foraging. Specifically, we examined shorebird responses to different levels of human use at trail sites versus non-trail sites to rigorously assess human presence (Hill et al. 1997) and assessed shorebird response to human use on lower versus higher use days at trail sites for insight into levels of disturbance that might affect foraging birds.

STUDY AREA

We observed shorebirds and human trail users at 3 locations around the San Francisco Bay: Bothin Marsh (Bothin) in Mill Valley, Marin County (37°53′N, 122°31′W), Redwood Shores (Redwood) in Redwood City, San Mateo County (37°31′N, 122°14′W), and Shoreline at Mountain View (Shoreline) in Mountain View, Santa Clara County (37°26′N, 122°03′W; Fig. 1). We chose these locations because each had mudflat adjacent to a levee with a trail as well as a non-trail site, within 2 km of the trail site, to function as a control site. We selected hydrologically similar sites that were completely or substantially open to the tides and provided exposed mudflat adjacent to the study sites at each low tide. At each trail site, the trail extended along the top of a levee constructed adjacent to a tidal wetland where mudflats were exposed at low tide. Each multi-use trail was ≥3.5 m wide with a solid, compacted surface and each was identified on San Francisco Bay Trail maps and other

[1] *E-mail address: ltrulio@earthlink.net*

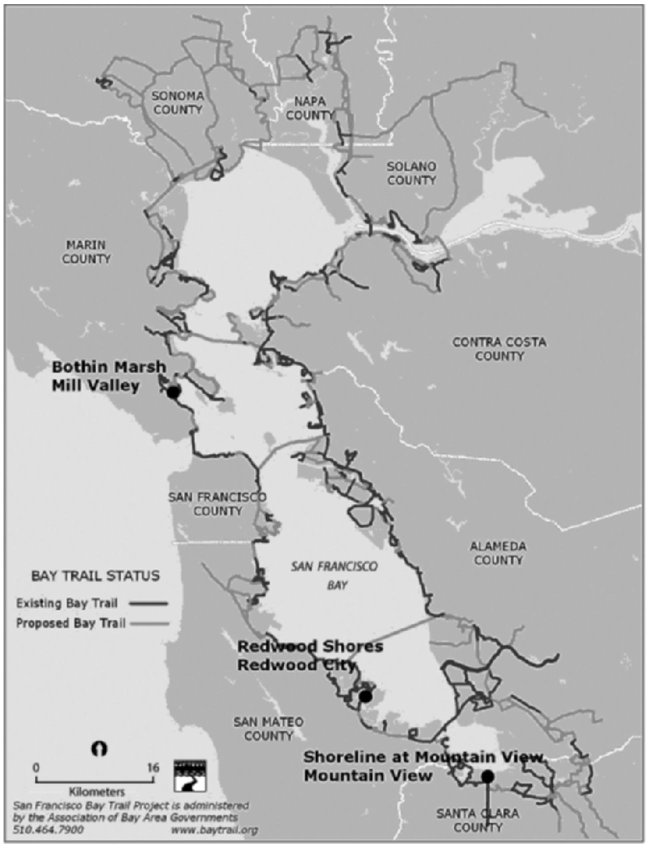

Figure 1. San Francisco Bay, California, USA, shorebird study locations for 1999–2001 at Bothin Marsh, Redwood Shores, and Shoreline at Mountain View, with existing and proposed alignments of the San Francisco Bay Trail system (reproduced with permission of the San Francisco Bay Trail).

publications promoting public use. Motorized vehicles were prohibited at all sites. The landward edge of the mudflat was $\leq$10 m from the edge of the trail and the levee was elevated approximately 3.5 m above the tidal mudflat. There was little to no vegetation between levees and mudflats. Sites without trails also had a levee or elevated land adjacent to the marsh but had no improved official trail. At 2 locations, locked gates blocked public access to sites without trails. At the third non-trail site, public access was effectively discouraged by the absence of an improved trail, which made access to the site difficult.

METHODS

During 24 months, from 1 July 1999 to 30 June 2000 and from 1 October 2000 to 30 September 2001, we observed birds at fixed 30.5-m $\times$ 30.5-m quadrats 4 times per month, on 2 weekend days and 2 weekdays. At each of the 3 locations, we established a quadrat at both trail and non-trail sites marked by plastic poles inserted in the mudflat. At each location, 2 observers collected data at the trail quadrat while 2 others collected data simultaneously at the non-trail quadrat for 4-hour observation periods during comparable times of the outgoing tidal cycle. Because data were collected simultaneously, weather was not a confounding factor when comparing trail to non-trail data for each observation period. No observations took place during extreme rain or wind events.

Observers arrived at study sites 15 minutes in advance of the observation period to minimize their impacts. They collected data from chairs located approximately 10 m outside the study quadrat. We collected data during the receding tide beginning 30–90 minutes after slack high tide. Observers used 10 $\times$ 50-power binoculars to record number of birds of each species and number of birds foraging versus other behaviors inside the entire quadrat every 5 minutes, yielding 48 scan-samples of bird activity during each observation period (Altmann 1974). We combined these scan-samples for analysis. Observers also continuously counted trail users passing by the quadrat and recorded their activities to give the total number of trail users per 4-hour observation period per day.

In year 2 of the study, we moved all non-trail quadrats to locations within 1 km of the first year's site to capture a wider range of natural variability. Non-trail sites in year 2 shared similar physical characteristics with those in year 1. Therefore, we had 6 different trail–non-trail pairs for analysis (3 locations $\times$ 2 trail–non-trail quadrat pairs = 6 trail–non-trail quadrat pairs).

Although we recorded data on all birds, we considered only shorebirds. We divided the year into 4 seasons reflecting major pulses in migratory shorebird movements observed during the study (spring = 1 Feb to 30 Apr; summer = 1 May to 30 Jun; autumn = 1 Jul to 31 Oct; winter = 1 Nov to 31 Jan). We observed few shorebirds in the 2 summer months, so we excluded this season from analysis. We calculated number of birds by summing bird counts for all 5-minute scan-samples during each 4-hour observation period (48 scan-samples/4 hr) and dividing by 48 to give the average number of birds seen per scan-sample in each quadrat per day. This parameter was not a measure of abundance, but rather a measure of relative bird use, because birds were sometimes counted more than once. Because all quadrats were the same size, the average number of birds per sample was directly comparable between quadrats. Rather than estimating distances between birds and the levee, we assessed the aggregate response of birds within the entire quadrat. Species richness was the number of unique species observed per day and proportion of birds foraging was the number of birds exhibiting foraging behavior divided by the total number of birds counted. Number of trail users per day was the total number of people we counted passing quadrats during each 4-hour observation period.

We used SYSTAT 12® (SYSTAT Software, Inc., Richmond, CA) to conduct analyses using repeated-measures linear mixed models. We transformed number of birds, species richness, and number of trail users using a $\ln(x + 1)$ transformation to meet assumptions for normality and homogeneity of variances and we arcsine-transformed the proportion of birds foraging. For the 3 response variables—number of birds, species richness, and proportion of birds foraging—and for number of trail users (an explanatory

Table 1. Numbers of humans, shorebirds per scan-sample, shorebird species richness, and percent of shorebirds foraging per 4-hour observation period measured at 3 locations around San Francisco Bay, California, USA, 1999–2001.

Variable	Trail			Non-trail			Lower use			Higher use		
	$\bar{x}$	SE	*n*	$\bar{x}$	SE	*n*	$\bar{x}$	SE	*n*	$\bar{x}$	SE	*n*
No. humans	270	19.4	239	3	0.4	240	148	11.3	120	393	34.0	119
No. birds	3.3	0.3	239	4.5	0.5	240	3.8	0.5	120	2.8	0.4	119
Species richness	3.1	0.1	239	2.8	0.1	240	3.2	0.2	120	3.0	0.2	119
% foraging	77	1.9	225	73	2.1	224	77	2.7	116	77	2.9	109

variable), we subtracted non-trail data from trail data for each observation period and used these differences for the trail–non-trail analyses. We ran analyses for each response variable with location, season, and difference in number of trail users at trail and non-trail sites as explanatory variables. We included the 6 quadrat pairs in the analysis as the subject for repeated measures, with an autoregressive covariance structure (AR 1) to account for correlations between consecutive measures taken on the same subject. To compare bird responses between lower use and higher use days, we ran repeated-measures linear mixed models using the data collected from trail sites. For these analyses, we calculated the difference in bird responses and difference in numbers of trail users by subtracting data for each weekday from its paired weekend day. In several cases, the weekday trail use was higher than the use on the paired weekend day; for these, we subtracted the lower (weekend day) from the higher (weekday) data.

RESULTS

Overall, 85% of birds we recorded were shorebirds and, of these, 67% were western and least sandpipers. Four other common taxa were dunlin (*Calidris alpina*; 10.2% of shorebirds), willets (*Tringa semipalmata*; 9.8%), long- and short-billed dowitchers (6.5%), and marbled godwits (3.5%). In total, we observed 15 shorebird taxa (American Ornithologists' Union 1998): killdeer (*Charadrius vociferus*), black-bellied plover (*Pluvialis squatarola*), semipalmated plover (*Charadrius semipalmatus*), black-necked stilt, American avocet, lesser (*Tringa flavipes*) and greater yellowlegs (*T. melanoleuca*), willet, whimbrel (*Numenius phaeopus*), marbled godwit, long-billed curlew (*N. americanus*), ruddy (*Arenaria interpres*) and black turnstone (*A. melanocephala*), least and western sandpiper, dunlin, short- and long-billed dowitcher, and red-necked phalarope (*Phalaropus lobatus*). Numbers of birds per scan-sample averaged 3.3 (SE = 0.3) and 4.5 (SE = 0.5) at trail and non-trail sites, respectively (Table 1). Species richness per day averaged 3.1 (SE = 0.1) and 2.8 (SE = 0.1), and percent (proportion × 100) of birds foraging averaged 77 (SE = 1.9) and 73 (SE = 2.1) at trail and non-trail sites, respectively (Table 1).

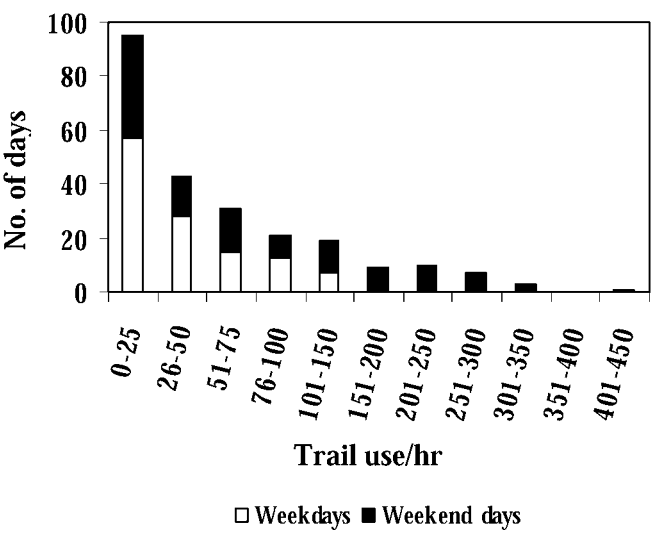

Figure 2. Numbers of weekdays and weekend days on which different levels of human trail use occurred at 3 locations around San Francisco Bay, California, USA, 1999–2001.

Human use at trail sites averaged 68 people/hour (SE = 4.9; 270 people/4-hr observation period), whereas use at non-trail sites averaged <1 people/hour (SE = 0.1). Weekday use at trail sites was ≤150 people/hour, whereas at its highest, weekend use exceeded 400 people/hour (Fig. 2). In general, use on weekends was approximately 2.5 times greater than use on weekdays (Table 1). Walkers, joggers, bicyclists, and in-line skaters dominated trail activities, comprising approximately 94% of trail uses. Approximately 3% of trail users were accompanied by dogs. Only approximately 1% of trail users stopped adjacent to the study quadrats to watch birds, take photographs, talk to trail observers, or for some other purpose.

The interaction between number of trail users and season provided some evidence that the difference in number of birds at trail versus non-trail sites was related to differences in number of trail users ($F_{2,239} = 2.88$, $P = 0.058$); this interaction was due to an increase in the numbers of birds per scan-sample in winter as human trail use increased (Fig. 3A). Average species richness, overall, also showed a positive relationship with the number of trail users ($F_{1,239} = 5.29$, $P = 0.022$; Fig. 3B) when comparing trail to non-trail sites. There was no evidence of a relationship between number of trail users and proportion of birds foraging overall ($F_{1,209} = 1.12$, $P = 0.292$) or by season ($F_{2,209} = 0.09$, $P = 0.909$) at trail versus non-trail sites.

Number of birds per scan-sample declined as number of trail users increased on higher use days versus lower use days ($F_{1,119} = 4.20$, $P = 0.043$; Fig. 4). On average, the number of birds per scan-sample during higher use days was 2.8 birds, approximately 25% less than the number of birds on lower use days (3.8 birds/scan-sample; Table 1). Average species richness on lower use versus higher use days was not related

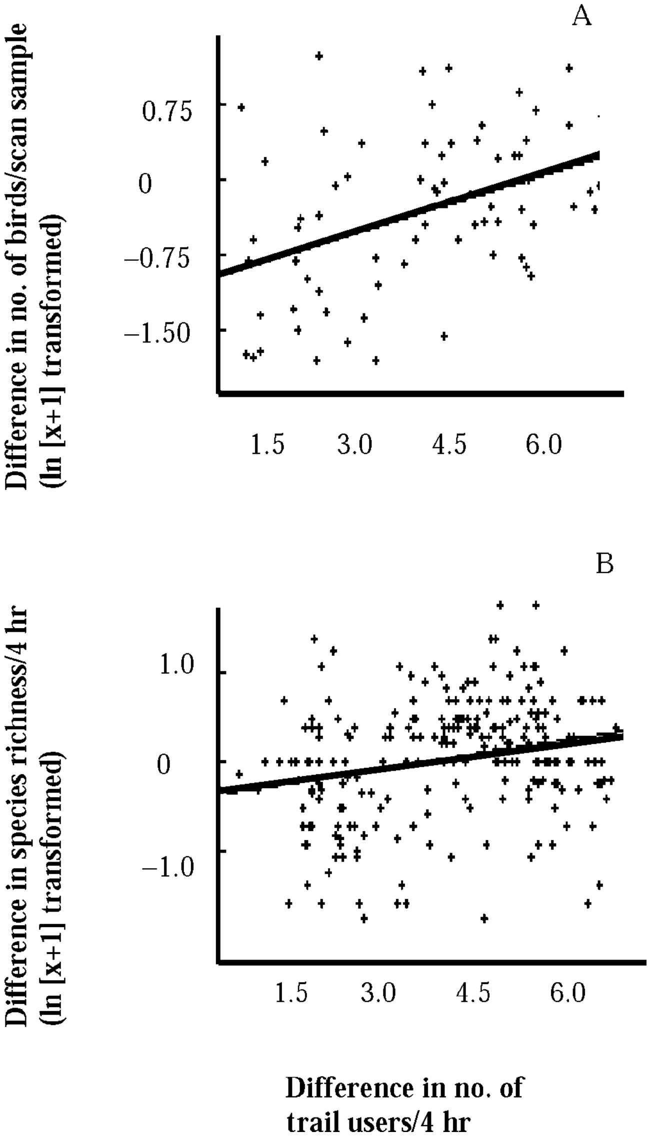

Figure 3. The difference in number of trail users/4-hour observation period shows a positive relationship with the difference in number of birds/scan-sample in winter (A) and species richness/4-hours overall (B) for trail minus non-trail data, San Francisco Bay, California, USA, 1999–2001.

to trail use overall ($F_{1,119} = 2.17$, $P = 0.144$) and did not vary by season ($F_{2,119} = 1.82$, $P = 0.168$). There was no evidence that proportion of birds foraging differed between high- and low-use days relative to number of trail users overall ($F_{1,105} = 1.66$; $P = 0.201$) or by season ($F_{2,105} = 1.65$; $P = 0.198$).

DISCUSSION

Despite major differences in numbers of trail users, we found no adverse effects of trail use, comparing trail to non-trail sites, on numbers of shorebirds, species richness, or proportion of birds foraging within the range of human use we observed. In fact, we found that species richness overall and number of birds per scan-sample in winter increased with increasing trail use. We did, however, find that the number of birds decreased at trail sites as trail use increased on higher use over lower use days.

At locations where shorebirds have exhibited few adverse responses to overall trail use, other local or landscape-level factors, such as habitat quality or predation risk, were likely more important than trail use to bird presence and foraging (Gill et al. 2001*a*; Yasue 2005, 2006). In a study of bird response to beach activities in southern California, Lafferty (2001) found that, although human activity varied primarily between weekdays and weekends, bird density varied most strongly with season and tide. Although birds on the beach were disturbed by people, presence of people "did not alter the large-scale patterns of beach use by the birds" (Lafferty 2001:1949).

In addition to landscape-scale factors, the low response of shorebirds to trail use at our locations may also be due to a number of site-specific factors. First, trails were all parallel to foraging areas and only 1–2% of trail users stopped to look at or directly approach birds. A number of researchers have found that indirect approach may reduce disturbance to waterbirds compared to direct approaches (Burger and Gochfeld 1981, Klein 1993, Rodgers and Schwikert 2003). Second, because motorized vehicles were prohibited on trails, sudden loud noises and rapid movements were not common. In general, the louder and faster the vehicle approaches, the greater the wildlife response (Rodgers and Schwikert 2002, 2003). Trail use at our locations was continual and low intensity, which causes less disturbance than infrequent or high-intensity activities (Hill et al. 1997). Third, shorebirds may allow human approach closer than other waterbirds because their small physical size allows them to take flight and escape more quickly than large waterbirds (Rodgers and Schwikert 2003, Blumstein 2006). In addition, dogs, which can be a significant disturbance factor for shorebirds (Lafferty 2001), were uncommon. Finally, birds at our trail sites may have become habituated to human presence. Ikuta and Blumstein (2003) studied flight distances of shorebirds and herons at 3 southern

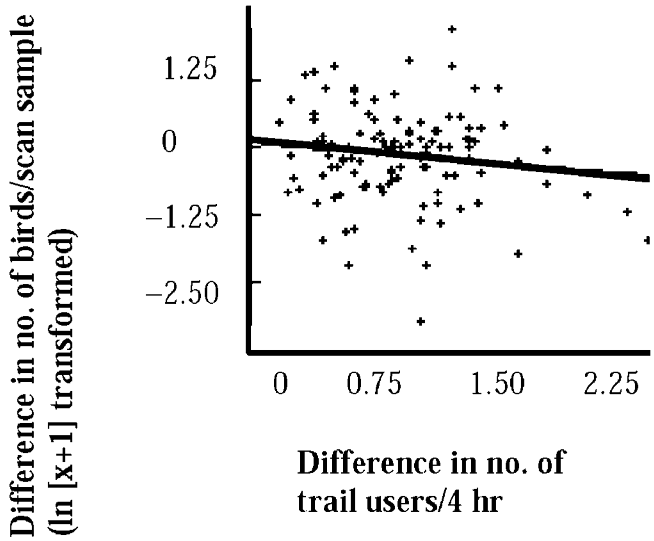

Figure 4. The difference in number of trail users/4-hour observation period shows a negative relationship with the difference in the number of birds/scan-sample for higher use minus lower use data, San Francisco Bay, California, USA, 1999–2001.

California wetlands and found birds had greater flight-initiation distances at sites with lower levels of human use, suggesting that birds became habituated to humans in high-use areas.

It is possible that birds may stay and forage in areas where human use is high because they lack alternative foraging opportunities (Gill et al. 2001*b*), whereas birds that leave an area when people are present may have other options or be in better physical condition to take advantage of more distant foraging sites (Beale and Monaghan 2004). In San Francisco Bay, it is not likely that shorebirds were limited by foraging opportunities and, thereby, forced to feed adjacent to busy levees. If human disturbance were a factor, we would expect higher numbers of birds at non-trail versus trail sites in response to trail use, which is not what we observed. In addition, shorebirds in the San Francisco Bay currently have huge expanses of tidal mudflat on which to forage and they need not forage near busy levees. In the vicinity of the Redwood and Shoreline locations, for example, there are approximately 55 km^2 of mudflats at low tide (Warnock and Takekawa 1995) and another 6 km^2 of moderate- to low-salinity salt ponds, which also provide valuable shorebird foraging opportunities (Warnock et al. 2002).

Although trail sites did not produce adverse bird responses compared to non-trail sites, we did find that as human use increased at trail sites on higher use days over lower use days, number of birds decreased. Whether this trend would continue with even greater differences in human use requires further study. However, there is ample evidence from other studies that recreation, including trails, can significantly impact waterbirds, especially larger bird species (Blumstein 2006), nesting birds (Carney and Sydeman 1999, Ruhlen et al. 2003), and birds not habituated to human activity (Ikuta and Blumstein 2003). There is also increasing evidence that dogs, both on- and off-leash, can have negative effects on the number of birds and bird species present (Yalden and Yalden 1990, Lafferty 2001, Banks and Bryant 2007). Finally, trail use may have other impacts such as preventing birds from roosting in trail-use areas (Pfister et al. 1992, Warnock and Takekawa 1995).

MANAGEMENT IMPLICATIONS

Our results indicate that, under certain conditions, managers may allow responsible types and levels of trail use in areas adjacent to tidal mudflats where migratory and resident shorebirds forage. Potentially acceptable types of recreational conditions are those where motorized vehicles and other high-noise and high-speed activities are excluded, where humans do not approach shorebirds directly, and where birds have become accustomed to human presence. Managers should take care in placing trails next to foraging sites because high levels of trail use may have adverse effects. In addition, bird responses will differ by location and over time based on many factors including prey abundance, predator pressure, physical site conditions, adjacent land uses, type and location of recreational activities, and bird experiences (Rodgers and Schwikert 2003, Beale and Monaghan 2004, Yasue 2006). Ultimately, although migratory shorebirds may choose to forage near trails, the lack of complete information on trail-use impacts to birds indicates that managers should provide substantial, high-quality areas not adjacent to trails to offer birds alternative, undisturbed areas for foraging and other activities.

ACKNOWLEDGMENTS

We thank our site supervisors, D. Chromczak, L. Hug, I. Harrald, and S. Casto, as well as our >2 dozen field observers. Many organizations supported and funded this research including the San Francisco Bay Trail Project, San Francisco Bay Conservation and Development Commission, California Coastal Conservancy, California Trails & Greenways Foundation, Cargill Salt Company, East Bay Regional Park District, National Park Service, Oracle Corporation, Vandenberg/Lipton, Varian Foundation, and Midpeninsula Regional Open Space District. We established study sites with the help of J. Albertson and C. Morris, United States Fish and Wildlife Service; R. Parmer and T. Le Blanc, Department of Fish and Game; D. Hansen and S. Petterle, Marin Open Space District; G. Lyles, City of Mountain View; P. Vorametsanti, Redwood City; L. Johnson, C. Taylor and J. Singleton, Cargill Salt Company. This manuscript benefited from the review and contributions of S. Bros, J. Geibel, P. Law, D. LeFer, R. Parmer, L. Stenzel, J. Rodgers, M. Josselyn, J. Evens, M. Erwin, and journal reviewers.

LITERATURE CITED

Altmann, J. 1974. Observational study of behavior: sampling methods. Behavior 48:227–265.

American Ornithologists' Union. 1998. The A.O.U. check-list of North American birds. Seventh edition. <http://www.aou.org/checklist/index.php3>. Accessed 15 Oct 2007.

Banks, P. S., and J. V. Bryant. 2007. Four-legged friend or foe? Dog walking displaces native birds from natural areas. Biology Letters 3:611–613.

Beale, C. M., and P. Monaghan. 2004. Behavioural responses to human disturbance: a matter of choice? Animal Behaviour 68:1065–1069.

Bishop, M. A., and N. Warnock. 1998. Migration of western sandpipers: links between their Alaskan stopover areas and breeding grounds. Wilson Bulletin 110:457–462.

Blumstein, D. T. 2006. Developing an evolutionary ecology of fear: how life history and natural history traits affect disturbance tolerance in birds. Animal Behaviour 71:389–399.

Bouton, S. N., P. C. Frederick, C. D. Rocha, A. T. Barbosa dos Santos, and T. C. Bouton. 2005. Effects of tourist disturbance on wood stork nesting success and breeding behavior in the Brazilian Pantanal. Waterbirds 28: 487–497.

Burger, J. 1981. The effect of human activity on birds at a coastal bay. Biological Conservation 21:231–241.

Burger, J. 2000. Landscapes, tourism, and conservation. The Science of the Total Environment 249:39–49.

Burger, J., and M. Gochfeld. 1981. Discrimination of the threat of direct versus tangential approach to the nest by incubating herring and great black-backed gulls. Journal of Comprehensive Physiology and Psychology 95:676–684.

Burger, J., and M. Gochfeld. 1998. Effects of ecotourists on bird behavior at Loxahatchee National Wildlife Refuge, Florida. Environmental Conservation 25:13–21.

Burger, J., M. Gochfeld, and L. J. Niles. 1995. Ecotourism and birds in

coastal New Jersey: contrasting responses of birds, tourists and managers. Environmental Conservation 22:56–65.
Burton, N. H. K., M. J. S. Armitage, A. J. Musgrove, and M. M. Rehfisch. 2002. Impacts of man-made landscape features on numbers of estuarine waterbirds at low tide. Environmental Management 30:857–864.
Carney, K. M., and W. J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22:68–79.
Gill, J. A., K. Norris, and W. J. Sutherland. 2001*a*. The effects of disturbance on habitat use by black-tailed godwits, *Limosa limosa*. Journal of Applied Ecology 38:846–856.
Gill, J. A., K. Norris, and W. J. Sutherland. 2001*b*. Why behavioral responses may not reflect the population consequences of human disturbance. Biological Conservation 97:265–268.
Hill, D. A., D. Hockin, D. Price, G. Tucker, R. Morris, and J. Treweek. 1997. Bird disturbance: improving the quality and utility of disturbance research. Journal of Applied Ecology 34:275–288.
Ikuta, L. A., and D. T. Blumstein. 2003. Do fences protect birds from human disturbance? Biological Conservation 112:447–452.
Klein, M. L. 1993. Waterbird behavioral response to human disturbances. Wildlife Society Bulletin 21:31–39.
Klein, M. L., S. R. Humphrey, and H. F. Percival. 1995. Effects of ecotourism on distribution of waterbirds in a wildlife refuge. Conservation Biology 9:1454–1465.
Lafferty, K. D. 2001. Birds at a southern California beach: seasonality, habitat use and disturbance by human activity. Biodiversity and Conservation 10:1949–1962.
Page, G. W., L. E. Stenzel, and J. E. Kjelmyr. 1999. Overview of shorebird abundance and distribution in wetlands of the Pacific Coast of the contiguous United States. Condor 101:461–471.
Pfister, C., B. A. Harrington, and M. Lavine. 1992. The impact of human disturbance on shorebirds at a migration staging area. Biological Conservation 60:115–126.
Rodgers, J. A., Jr., and S. T. Schwikert. 2002. Buffer zone distances to protect foraging and loafing waterbirds from disturbance by personal watercraft and outboard-powered boats. Conservation Biology 16:216–224.
Rodgers, J. A., Jr., and S. T. Schwikert. 2003. Buffer zone distances to protect foraging and loafing waterbirds from disturbance by airboats in Florida. Waterbirds 26:437–443.
Ruhlen, T. D., S. Abbott, L. E. Stenzel, and G. W. Page. 2003. Evidence that human disturbance reduces snowy plover chick survival. Journal of Field Ornithology 74:300–304.
U.S. Department of the Commerce. 2005. More than 30 cities and 20 states and territories post double-digit growth in overseas visitation in 2004. Press release. <http://www.commerce.gov/opa/press/Secretary_Gutierrez/2005_Releases/June/29_Visitation.htm>. Accessed 26 Oct 2006.
Warnock, N., G. W. Page, T. D. Ruhlen, N. Nur, J. Y. Takekawa, and J. T. Hanson. 2002. Management and conservation of San Francisco Bay salt ponds: effects of pond salinity, area, tide, and season on Pacific flyway waterbirds. Waterbirds 25:79–92.
Warnock, S., and J. Y. Takekawa. 1995. Habitat preferences of wintering shorebirds in a temporally changing environment: western sandpipers in the San Francisco Bay estuary. Auk 112:920–930.
Yalden, P. E., and D. W. Yalden. 1990. Recreational disturbances of breeding golden plovers *Pluvialis apricarius*. Biological Conservation 51: 243–262.
Yasue, M. 2005. The effects of human presence, flock size and prey density on shorebird foraging rates. Journal of Ethology 23:199–204.
Yasue, M. 2006. Environmental factors and spatial scale influence shorebirds' responses to human disturbance. Biological Conservation 128:47–54.

Associate Editor: Steidl.