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Piping Plovers *Charadrius melodus* and dogs: compliance with and attitudes toward a leash law on public beaches at Lake McConaughy, Nebraska, USA

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Humans often recreate with their dogs *Canis familiaris* on public beaches; beaches that may also be used as breeding habitat by imperiled shorebirds. The Piping Plover *Charadrius melodus* is one such shorebird and is protected by the Endangered Species Act 1973 (ESA) in the United States. Dogs, especially dogs that are not restrained and allowed access to breeding areas because their owners choose not abide by "leash laws", will sometimes negatively impact Piping Plovers. We evaluated leash-law compliance and recreationists' awareness of and attitudes toward leash laws at Lake McConaughy, Nebraska, USA, during 2013–2014. Leash-law compliance was chronically low (< 25% of all dogs observed) during all days and time periods we evaluated, even though 78.1% of recreationists with dogs were aware of the leash-law requirements. All 487 individuals surveyed possessed favorable attitudes towards Piping Plovers and continued dog access to the beach, while having generally unfavorable attitudes toward unleashed dogs. It appears the potential exists at Lake McConaughy to improve leash-law compliance through a comprehensive program that uses education, enforcement and reinforcement of social norms.

INTRODUCTION

Domestic dogs *Canis familiaris* are one of the most commonly kept pets in the United States (Stallones *et al.* 1990). Dog owners typically have strong emotional attachments toward their pets, often considering them to be family members (Albert & Bulcroft 1988) and include them in all aspects of their lives, including recreation (Ham & Epping 2006). Often outdoor recreation with dogs takes place at public-use sites in parks and wildlife areas that may also serve as important wildlife habitat. The presence of dogs, whether the dogs are on or off leashes and accompanied by humans or feral and unaccompanied, has the potential to negatively affect native wildlife and wildlife habitats (Lenth *et al.* 2008, Young *et al.* 2011).

Sandy beaches along oceans and surrounding lakes and reservoirs are attractive to humans for recreation and receive intensive use, particularly during the spring and summer. Recreationists often bring their pet dogs with them and engage in various forms of recreation, such as camping, swimming, fishing, boating, picnicking, running, and walking. Many of these same beaches are important ecosystems supporting rare aquatic and terrestrial wildlife (Defeo *et al.* 2009) year round, but are especially important during breeding seasons. The presence of dogs on beaches has the potential to negatively impact species such as turtles (Fowler 1979) and birds (Lafferty 2001a). Dogs are known to directly impact shorebirds that nest and rear young on sand beaches (Cairns & McLaren 1980, Lafferty 2001a, 2001b, Weston & Elgar 2007, Williams *et al.* 2009).

Piping Plovers *Charadrius melodus* are shorebirds that frequently nest on public beaches and other sites, along the Atlantic Coast, Great Lakes, and Great Plains (Elliot–Smith & Haig 2004). Plovers are federally listed as either threatened (Atlantic Coast, Great Plains) or endangered (Great Lakes) under authority of the Endangered Species Act 1973 (ESA; 7 U.S.C. § 136, 16 U.S.C. § 1531 *et seq.*). In order to comply with the ESA and corresponding state statutes, management actions that include site restrictions are often implemented to avoid or minimize negative impacts to plovers caused by recreation (Melvin *et al.* 1991, U.S. Fish and Wildlife Service 1996, 2003). While the presence of human recreation at Piping Plover breeding sites is a known source of disturbance, nest destruction and chick mortality (Burger 1991, Flemming *et al.* 1988, Melvin *et al.* 1994), human recreation in close proximity to breeding birds does not always result in negative consequences to the birds (Patterson *et al.* 1991).

One of the principal management actions implemented to avoid negative impacts to Piping Plovers from dogs on breeding beaches are regulations that require dogs to be restrained on leashes (Melvin *et al.* 1991, U.S. Fish and Wildlife Service 1996, 2003). The effectiveness of these 'leash laws' depends upon human compliance with the regulations and humans with dogs maintaining a distance from nests that does not disturb incubating Piping Plovers. The

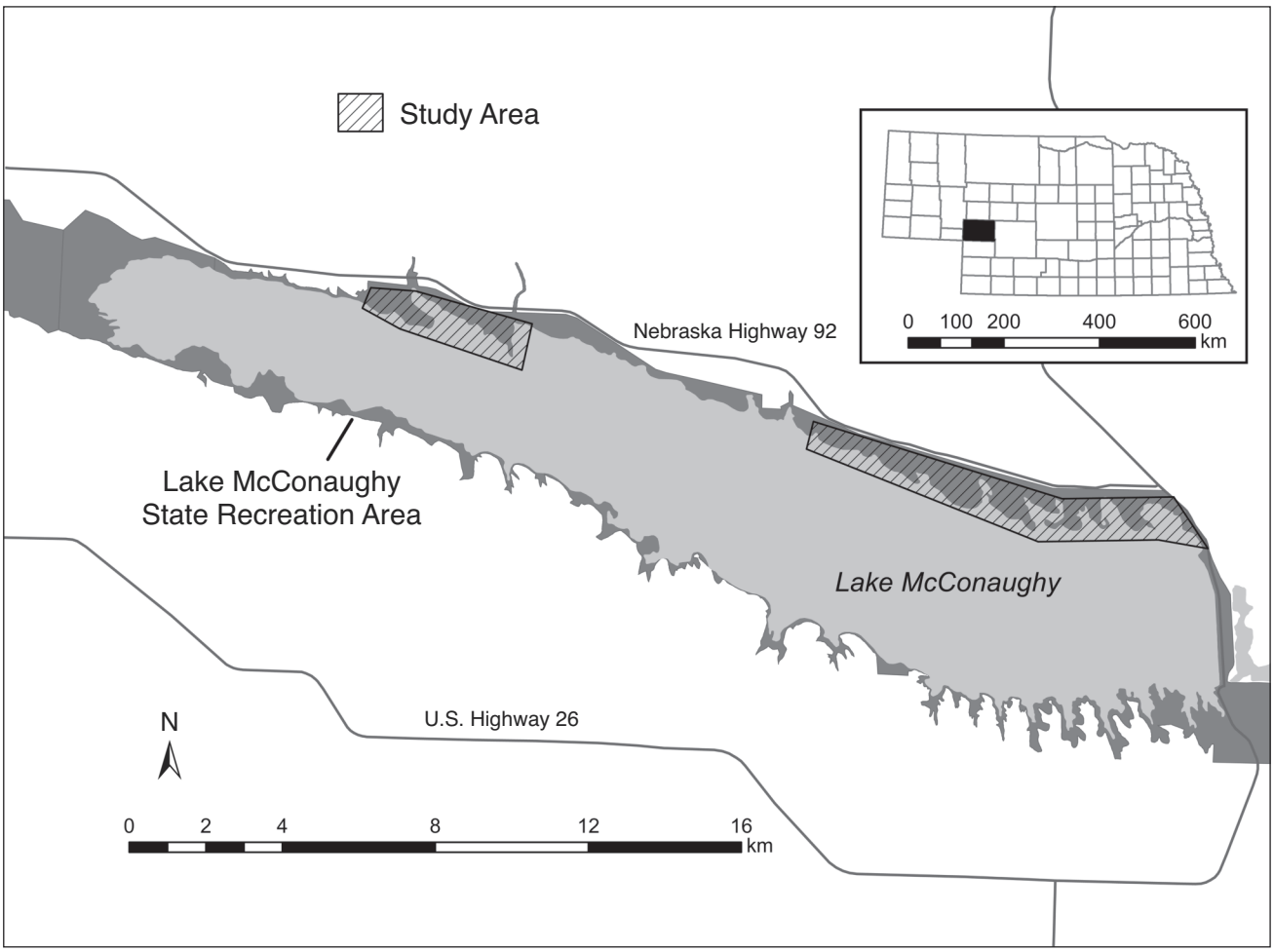

Fig. 1. Location of the Lake McConaughy State Recreation Area (dark gray), Keith County, Nebraska, USA, and the study area (crosshatched).

latter is often addressed by implementing human exclusion zones in areas where nesting Piping Plovers are present. Piping Plover recovery plans (U.S. Fish and Wildlife Service 1996, 2003) identify leash-law compliance as being an important issue in the protection of birds, but recognize that compliance rates may be low without the continuing presence of enforcement or education, or both. In Australia, an analogous situation exists on beaches with breeding Hooded Plovers *Thinornis rubricollis*. Williams *et al.* (2009) showed that low leash-law compliance was attributable to several factors including (1) dog owners believing wildlife protection was important, but greater importance was placed on the benefits of unleashed exercise for their dog, (2) dog owners possessed a poor understanding of the specific negative effects unleashed dogs may have on Hooded Plovers, and (3) dog owners acknowledged dogs may negatively impact Hooded Plovers, but they did not believe their own dog's behavior could result in negative impacts.

Unleashed dogs are thought to negatively impact breeding Piping Plovers at Lake McConaughy, located near Ogallala, in Keith County, Nebraska, USA (41°14'09.6"N 101°44'27.0"W; Peyton & Wilson 2008), but evidence demonstrating the nature and intensity of the impact is lacking; compliance rates with the leash law are perceived to be low (JGJ, MBB, pers. obs.). State and federal wildlife protection agencies (e.g. Nebraska Game and Parks Commission and U.S. Fish and Wildlife Service) are focusing increased attention on improving leash-law compliance rates with managers distributing educational material with information about Piping Plovers and leash-law requirements. In 2013 and 2014, we studied dog presence, leash-law compliance, and recreationists' awareness and attitudes toward Piping Plovers and leash laws to improve our understanding of the challenges surrounding this issue and the effectiveness of education initiatives. Our specific objectives were to determine (1) leash-law compliance rates, (2) recreationists' awareness about the existence of leash laws, and (3) the importance recreationists place on dog access to beaches. Dog and leash-law compliance surveys were conducted concurrently with a behavioral study of Piping Plovers attending nests.

METHODS

Study area

Lake McConaughy is a human-created reservoir owned and operated by the Central Nebraska Public Power and Irrigation District (CNPPID) to provide water for irrigation, hydroelectric power generation and recreation. The lake was formed when Kingsley Dam was completed in 1941 and impounds water from the North Platte River. Lake McConaughy is an important nesting area for the Great Plains population of Piping Plovers. Breeding numbers range from 10s to low 100s, with a high of 358 adults recorded in 2006 (Elliot-Smith *et al.* 2009). The number of nesting birds is dependent on the amount of suitable habitat

available to them and that is largely dictated by annually varying water levels in the lake. The Nebraska Game and Parks Commission (NGPC) leases property around Lake McConaughy and manages part of it as a State Recreation Area (SRA) and part as a Wildlife Management Area (WMA). In recent years, more than one million people per year have visited and used Lake McConaughy SRA, mostly during the summer months (NGPC, unpubl. data).

Dogs are allowed on the beaches of Lake McConaughy provided they are restrained on a 6-foot leash. Signs with information about the leash law are located at beach access points. Dog owners that do not abide by the leash law can be cited and fined under Nebraska regulations (Nebraska Administrative Code Title 163, Chapter 5, Section 001). Nearly all dogs found on the beaches at Lake McConaughy are associated with shoreline campsites or site-specific day-use facilities (e.g. boat ramps, picnic areas, swimming beaches, fish cleaning stations). Due to its relative remoteness from populated areas, there is little to no use of the beaches for daily pet exercise (e.g. morning runs, evening walks) purposes.

Recreationist surveys and dog observations

Piping Plovers and their breeding areas are not uniformly distributed around Lake McConaughy and access to some areas is limited. Therefore, we restricted our study to areas along the north side of Lake McConaughy SRA that we identified as being (1) important Piping Plover breeding areas and (2) frequently used for human recreation (Fig. 1). In both years of the study the water level in Lake McConaughy was at less than 75% of full pool and extensive areas of sand were present around the shoreline.

Our study took place from 20 May to 15 July in both 2013 and 2014. We stratified the study period into three types of day – weekdays, weekends, and holiday weekends – because recreational use is generally greater on weekends and holidays (NGPC, unpubl. data). We prioritized holidays and weekends because (1) there were fewer of them during the study period and (2) we expected more recreationists to be present on the beaches during those days. We defined weekends as Saturday and Sundays, holiday weekends as federal holidays (Memorial Day and the Fourth of July) including the nearest weekend, and weekdays as Monday to Friday except those days classified as holiday weekends. We selected five days per week to conduct behavioral observations and personal interview surveys of recreationists. We divided each week into 8-hour days with the start time moving between morning, midday, and afternoon so the entire 'recreation day' was covered in our surveys. Each 8-hour work day was during a 12-hour period extending from 07h30 to 19h30 local time.

During the initial study period (first 12 days in 2013 and first 8 days in 2014), two observers navigated to randomly assigned sites using a hand-held GPS to locate Piping Plover nests. To establish sites, we digitized a polyline in an Arcmap shapefile (using Farm Service Agency [2012] aerial photographs; ESRI 2011) to delineate the interface between permanent vegetation and the open sandy beach utilized for plover nesting habitat. We divided the polyline into 200 m segments and placed points at the end of each segment. We refer to the area 100 m on either side of each point and extending to the shoreline as a site. CNPPID (2002) annually monitors and implements nest-protection measures at Lake McConaughy; thus, nest locations within our sites were easily identifiable. If a Piping Plover nest was located at a site, the observers counted the number of leashed and unleashed dogs present for one hour. After all breeding sites in the study area were inventoried during the initial study period, observers (at least one per nest) visited nests throughout the remainder of the nesting season in an ordered rotation and completed additional one-hour-long dog surveys.

Recreationists' surveys

We evaluated recreationists' awareness of and attitudes toward Piping Plovers and leash laws at Lake McConaughy by conducting personal interview surveys following observation periods across the entire season. Two assistants trained to conduct this type of survey asked recreationists a series of questions to determine their demographic attributes, awareness of and attitudes about Piping Plovers, dog leash laws, and the importance of dog access and recreation at Lake McConaughy. The assistants did not interview any recreationist more than once per year. Recreationists in boats, recreational vehicles, or in tents were considered inaccessible and not surveyed.

We collected basic demographic attributes describing the respondents including sex and whether dogs did or did not accompany them during their visit to Lake McConaughy. Due to our University of Nebraska Institutional Review Board permit requirements, all respondents were 19 years of age or older. To determine their awareness of beach regulations, we asked respondents if (1) there was a dog leash law at Lake McConaughy and (2) if they had seen a leash law sign at Lake McConaughy. We asked respondents to respond to the following statements: (a) dog access to the beach is important, (b) allowing unleashed dogs on the beach is important, (c) Piping Plovers should be protected during the nesting season, and (d) would they be receptive to leash-law enforcement if it protected Piping Plovers. The last question was only asked during the second year of the study. Respondents were asked to rank their opinions on a scale of one to five, where the respective values meant strongly opposed (1), opposed (2), neutral (3), favor (4), and strongly favor (5). The distribution of survey responses did not differ between years, so surveys completed in 2013 and 2014 were combined in the following analyses.

We summarized dog presence, dog number, and leash-law compliance by demographic attribute, day-type, and day-period (morning [07h30 to 11h30], midday [11h30 to 15h30] and evening [15h30 to 19h30]). We summarized recreationists' responses into those with and those without dogs. We used chi-square (χ^2) or Kruskal-Wallis (H) tests to determine whether responses were statistically different by groups. All statistical analyses were completed using Program R (R Development Core Team 2008). We report the mean (±1SE) of the response for each query in the survey. Statistical significance levels were set at 0.05.

RESULTS

We conducted one-hour-long observations at a total of 257 sites with Piping Plover nests: 126 during weekdays, 84 during weekends, and 47 during holidays (Table 1). Summarized across the season, dogs were present at a higher percentage of sites during weekends (52.4%) and holidays (51.1%) than on weekdays (29.4%); a significant difference ($\chi^2 = 13.53$, df = 2, $P = 0.001$). More dogs were observed at

sites during weekends (70) than on weekdays (64) and holidays (41). The average number of dogs observed per site was highest during holidays (0.9) compared to weekends (0.8) and weekdays (0.5). Of all dogs observed on the beaches, only 16.0% were leashed. The percentage of all dogs leashed was higher during holidays (24.4%) than on weekdays (15.6%) and weekends (11.4%); however, these differences are not significant ($\chi^2 = 3.25$, df = 2, $P = 0.20$).

Dogs were present at more sites during midday (43.8%; Table 2) than during morning (40.6%) and evening (36.8%) time periods; but these differences are not significant ($\chi^2 = 0.90$, df = 2, $P = 0.64$). A greater total number of dogs was observed during midday (80) than during evening (48) and morning (47). The average number of dogs observed per site was similar between the morning (0.68), midday (0.71), and evening (0.63) time periods. The highest percentage of leashed dogs was observed during midday (17.5%) than during morning (17.0%) and evening (12.5%); but these differences are not significant ($\chi^2 = 0.61$, df = 2, $P = 0.73$).

We surveyed 487 recreationists, 269 in 2013 and 218 in 2014 (Table 3). Of all respondents, 277 were male and 210 were female. The percentage of male (53.1%) and female (47.6%) respondents that were accompanied by dogs was not significantly different ($\chi^2 = 1.42$, df = 1, $P = 0.234$). A significantly higher percentage of respondents with dogs (78.1%) than recreationists without dogs (67.1%) were aware of the leash law ($\chi^2 = 6.94$, df = 1, $P = 0.01$). A significantly higher percentage of recreationists with dogs (49.0%) than recreationists without dogs (34.2%) observed leash law signs during their visit ($\chi^2 = 10.4$, df = 1, $P = 0.001$).

Respondents with dogs responded more favorably (4.53 ±0.07) compared to respondents without dogs (3.49 ±0.11) to the statement "dog access to the beach is important"; the difference was significantly different (Kruskal-Wallis test; $H = 63.11$, df = 1, $P < 0.001$). Respondents with dogs responded more favorably (3.34 ±0.11) compared to respondents without dogs (2.20 ±0.10) to the statement "allowing unleashed dogs on the beach is important"; the difference was significantly different (Kruskal-Wallis test; $H = 55.07$, df = 1, $P < 0.001$). Respondents without dogs responded significantly more favorably (3.70 ±0.16) compared to respondents with dogs (3.15 ±0.15) to increased leash-law enforcement (Kruskal-Wallis test; $H = 5.03$, df = 1, $P = 0.02$).

DISCUSSION

Unleashed dogs are known to negatively impact Piping Plovers (Cairns & McLaren 1980, Melvin *et al.* 1991, Burger 1994) and are identified as threats to Piping Plovers in federal recovery plans (U.S. Fish and Wildlife Service 1996, 2003). However, chronically low rates of leash-law compliance are common in areas where beach-nesting plovers and humans with dogs co-occur (Dowling & Weston 1999, Hatch 1996, Lafferty 2001a, 2001b, Williams *et al.* 2009). In our study, dog presence was higher on holidays and weekends compared to weekdays, but leash-law compliance was similar across day type and day period. Higher leash-law compliance rates were observed on holidays, but the difference was not statistically significant. We speculate that higher compliance rates observed on holidays is attributable to increased numbers and density of recreationists, which would reduce the size of the area over which unleashed dogs could

Table 1. The number of sites surveyed, number and percent with dogs present, total number of dogs, mean number of dogs per site and number and percent leashed by day type.

	All	Weekday	Weekend	Holiday	
Total number of sites surveyed	257	126	84	47	
Number of sites with at least one dog present per hour	105	37	44	24	
% of sites with at least one dog present	40.9	29.4	52.4	51.1	$\chi^2 = 13.53$, df = 2, $P = 0.001$
Total number of dogs observed	175	64	70	41	
Mean number of dogs observed per site per hour (±SE)	0.7 ±0.2	0.5 ±0.2	0.8 ±0.1	0.9 ±0.2	
Number of dogs attached to leashes	28	10	8	10	
% of dogs attached to leashes	16.0	15.6	11.4	24.4	$\chi^2 = 3.25$, df = 2, $P = 0.20$

Table 2. The number of sites surveyed, number and percent with dogs present, total number of dogs, mean number of dogs per site and number and percent leashed by time of day.

	All	Morning	Midday	Evening	
Total number of sites surveyed	257	69	112	76	
Number of sites with at least one dog present per hour	105	28	49	28	
% of sites with at least one dog present	40.9	40.6	43.8	36.8	$\chi^2 = 0.90$, df = 2, $P = 0.64$
Total number of dogs observed	175	47	80	48	
Mean number of dogs observed per site per hour (±SE)	0.7 ±0.2	0.7 ±0.1	0.7 ±0.1	0.6 ±0.1	
Number of dogs attached to leashes	28	8	14	6	
% of dogs attached to leashes	16.0	17.0	17.5	12.5	$\chi^2 = 0.61$, df = 2, $P = 0.73$

wander before infringing on the space occupied by other recreationists. Our observations suggest that dog owners were responding to the presence of other recreationists, not the presence of the leash law. Overall, our results show that low leash-law compliance rates are not limited to specific time periods (time of week or time of day), but are chronically low during all periods examined by this study. This suggests that efforts to improve leash-law compliance rates, and hence Piping Plover protection, must be comprehensive, addressing people and birds throughout the entire breeding season.

A considerable amount of time, effort, and resources have been expended at Lake McConaughy to improve leash-law compliance and our results show recreationists' awareness about the leash law is relatively high, particularly when considering only those recreationists with dogs. This suggests that continuing to expend resources on education efforts intended only to increase awareness about the existence of the leash law is unlikely to improve leash law compliance appreciably. Two of three obstacles identified by Williams *et al.* (2009) for why humans chose not to leash their dog are lack of awareness about specific negative effects unleashed dogs may have on birds and disbelief that their dog may negatively impact birds. Our results suggest future education efforts at Lake McConaughy should include targeted messages explaining the purpose of the leash law and possible negative consequences to Piping Plovers caused by unleashed dogs.

Education is often the preferred management tool for resolving conflicts between humans and wildlife (Baruch-Mordo *et al.* 2011). But law enforcement action is known to dramatically improve leash-law compliance rates (Hatch 1996) and can be effective in resolving certain conflicts between humans and wildlife (Baruch-Mordo *et al.* 2011). However, maintaining the level of resource allocation needed for full-time and comprehensive leash-law enforcement is probably unrealistic for most law enforcement agencies. Nevertheless, future research must evaluate the effectiveness of proactive law enforcement in producing desirable outcomes related to leash-law compliance in areas used by Piping Plovers.

Williams *et al.* (2009) noted the strongest predictor for the presence of leashed dogs on beaches were dog owners implementing behaviors expected of them by other beach users – so-called social norms; the perceived social pressure from peers that dogs would be leashed. Williams *et al.* (2009) recommended implementing management strategies focused on the reinforcement of social norms to improve leash-law compliance. In our study, among all respondents, allowing unleashed dogs on the beach was viewed slightly unfavorably, Piping Plover protection was viewed favorably, and leash-law enforcement was viewed neutrally. Thus, there does not appear to be strong support for allowing dogs to be unleashed at Lake McConaughy even though dog access to the beach is viewed favorably to very favorably by all respondents. These results suggest a receptive environment exists at Lake McConaughy for applying efforts focused on the development and reinforcement of social norms.

Leash-law compliance superficially appears to be a straightforward management action, but it is complex. With an ever-increasing demand for resource agencies to do 'more with less', efforts to effectively improve leash-law compliance at Lake McConaughy and elsewhere will require a more sophisticated approach than isolated and undirected education or enforcement actions. Programs to improve compliance efficiently and effectively will need to be cohesive and comprehensive and use conceptual frameworks (Kollmuss & Agyeman 2002) that assist managers in understanding the sources of and linkages between attitudes, awareness, and behaviors.

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Table 3. Recreationists' responses to survey questions about leash laws, dog access and Piping Plover protection at Lake McConaughy. Ratings are based on a scale of 1–5, with 1 indicating least support and 5 indicating most support for the survey statement.

	All respondents	Dog owners	Other	
Number of respondents	487	247	240	
Is there a leash law at Lake McConaughy?	72.90%	78.10%	67.10%	$\chi^2 = 6.94$, df = 1, $P = 0.01$
Have you seen a leash law sign?	42.40%	49.00%	34.20%	$\chi^2 = 10.4$, df = 1, $P = 0.001$
Dog access to the beach is important	4.0 ±0.06	4.5 ±0.07	3.5 ±0.11	$H = 63.11$, df = 1, $P < 0.001$
Allowing unleashed dogs on the beach is important	2.9 ±0.07	3.3 ±0.11	2.2 ±0.10	$H = 55.07$, df = 1, $P < 0.001$
Piping Plovers should be protected during the nest season	4.5 ±0.08	4.3 ±0.07	4.7 ±0.18	$H = 3.02$, df = 1, $P = 0.08$
Would you be receptive to leash-law enforcement if it helped protect Piping Plovers?	3.5 ±0.15	3.2 ±0.15	3.7 ±0.16	$H = 5.03$, df = 1, $P = 0.02$

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REFERENCES

Albert, A. & Bulcroft, K. 1988. Pets, families, and the life course. *J. Marriage and the Family* 50: 543–552.

Baruch-Mordo S., Breck, S.W., Wilson, K.R., & Broderick, J. 2011. The carrot or the stick? Evaluation of education and enforcement as management tools for human-wildlife conflicts. *PLoS ONE* 6: e15681. doi:10.1371/journal.pone.0015681

Burger, J. 1991. Foraging behavior and the effect of human disturbance on the piping plover (*Charadrius melodus*). *J. Coastal Res.* 7: 39–52.

Burger, J. 1994. The effect of human disturbance on foraging behavior and habitat use in Piping Plover (*Charadrius melodus*). *Estuaries* 17: 695–701.

Cairns, W.E. & McLaren, I.A. 1980. Status of the Piping Plover. *American Birds* 34: 206–2008.

Central Nebraska Public Power and Irrigation District (CNPPID). 2002. Land and shoreline management Plan for the Kingsley Dam Project: Federal Energy Regulatory Agency License No. 1417. Central Nebraska Public Power and Irrigation District, Holdrege, Nebraska.

Defeo, O., McLachlan, A., Schoeman, D.S., Schlacher, T.A., Dugan, J., Jones, A., Lastra, M., & Scapini, F. 2009. Threats to sandy beach ecosystems: a review. *Est. Coastal & Shelf Sci.* 81: 1–12.

Dowling, B. & Weston, M.A. 1999. Managing a breeding population of the Hooded Plover *Thinornis rubricollis* in a high-use recreational environment. Bird Conservation International 9: 255–270.

Elliott-Smith, E. & Haig, S.M. 2004. Piping Plover (*Charadrius melodus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: *http://bna.birds.cornell.edu/bna/species/002doi:10.2173/bna.2* (accessed 27 August 2014).

Elliott-Smith, E., Haig, S.M., & Powers, B.M. 2009. Data from the 2006 International Piping Plover Census: U.S. Geological Survey Data Series 426. *http://pubs.usgs.gov/ds/426/pdf/ds426.pdf* (accessed 12 August 2014).

ESRI. 2011. ArcGIS Desktop: Release 10. Environmental Systems Research Institute. Redlands, CA.

Flemming, S.P., Chiasson, R.D., Smith, P.C., Austin-Smith, P.J., & Bancroft, R.P. 1988. Piping Plover status in Nova Scotia related to its reproductive and behavioral responses to human disturbance. *J. Field Ornith.* 59: 321–330.

Fowler, L.E. 1979. Hatching success and nest predation in the green sea turtle, *Chelonia mydas*, at Tortuguero, Costa Rica. *Ecology* 60: 946–955.

Ham, S.A. & Epping, J. 2006. Dog walking and physical activity in the United States. *Preventing Chronic Disease* 3: A47.

Hatch, D.A. 1996. Western Snowy Plover (a federally threatened species) wintering population and interaction with human activity on Ocean Beach, San Francisco, Golden Gate National Recreation Area, 1988 through 1996. Report, Golden Gate National Recreation Area. National Park Service, San Francisco, CA.

Kollmuss, A., & Agyeman, J. 2002. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environ. Educ. Res.* 8: 239–260.

Lafferty, K.D. 2001a. Birds at a southern California beach: seasonality, habitat use and disturbance by human activity. *Biodivers. & Conserv.* 10: 1949–1962.

Lafferty, K.D. 2001b. Disturbance to wintering Western Snowy Plovers. *Biol. Conserv.* 101: 315–325.

Lenth, B.E., Knight, R.L., & Brennan, M.E. 2008. The effects of dogs on wildlife communities. *Natural Areas Journal* 28: 218–227.

Melvin, S.M., Griffin, C.R., & Macivor, L.H. 1991. Recovery strategies for Piping Plovers in managed coastal landscapes. *Coastal Man.* 19: 21–34.

Melvin, S.M., Hecht, A., & Griffin, C.R. 1994. Piping Plover mortalities caused by off-road vehicles on Atlantic coast beaches. *Wildlife Soc. Bull.* 22: 409–414.

Patterson, M.E., Fraser, J.D., & Roggenbuck, J.W. 1991. Factors affecting Piping Plover productivity on Assateague Island. *J. Wildlife Man.* 55: 525–531.

Peyton, M.M. & Wilson, G.T. 2008. Least Tern and Piping Plover nest monitoring, final report 2008. Central Nebraska Public Power and Irrigation District, Holdrege, NE.

R Development Core Team. 2008. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. *http://www.R-project.org*.

Stallones, L., Marx, M.B., Garrity, T.F., & Johnson, T.P. 1990. Pet ownership and attachment in relation to the health of US adults, 21 to 64 years of age. *Anthrozoos* 4*:* 100–112.

U.S. Fish and Wildlife Service. 1996. Piping Plover (*Charadrius melodus*) Atlantic Coast population revised recovery plan. U.S. Fish and Wildlife Service, Hadley, VA.

U.S. Fish and Wildlife Service. 2003. Recovery Plan for the Great Lakes Piping Plover (*Charadrius melodus*). U.S. Fish and Wildlife Service. Fort Snelling, MN.

Young, J. K., Olson, K.A., Reading, R.P., Amgalanbaatar, S., & Berger, J. 2011. Is wildlife going to the dogs? Impacts of feral and free-roaming dogs on wildlife populations. *BioScience* 61: 125–132.

Weston, M.A. & Elgar, M.A. 2007. Responses of incubating Hooded Plovers (*Thinornis rubricollis*) to disturbance. *J Coastal Res.* 23: 569–576.

Williams, K.J., Weston, M.A., Henry, S., & Maguire, G.S. 2009. Birds and beaches, dogs and leashes: dog owners' sense of obligation to leash dogs on beaches in Victoria, Australia. *Human Dimensions of Wildlife* 14: 89–101.