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Impact perceptions and acceptance capacity toward Piping Plovers *Charadrius melodus* among visitors on a public beach in Nebraska, USA

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On an increasingly crowded planet, shorebirds and humans are frequently found sharing the same ecosystems. This development requires that the managers of these human-wildlife ecosystems address human dimensions challenges in addition to those associated with species biology. To better understand such challenges, we evaluated impact perceptions and overall acceptance capacity in visitors on public beaches of Lake McConaughy, Nebraska, USA towards a federally-protected shorebird, the Piping Plover *Charadrius melodus*. Overall acceptance capacity for these birds was relatively high and perceptions of inconvenience caused by the presence of the birds were low. However, acceptance capacity and impact perceptions varied depending on whether the visitor supported, was neutral or opposed protecting Piping Plovers. Awareness of the presence of Piping Plovers was the most important variable associated with negative attitudes towards the birds; the more aware visitors were of the birds, the more negative were their attitudes. The specific type of recreational activity a visitor was engaged in was not associated with their impact perceptions or acceptance capacity. Our study serves as an important baseline which can be used to determine whether awareness, impact perceptions, and acceptance capacity at this site change as recreational use, efforts to protect the species, and educational and management practices evolve.

Keywords

acceptance capacity
beach management
human dimensions
recreation
shorebirds
Piping Plover
Charadrius melodus

INTRODUCTION

Sandy coastal and inland beaches provide important habitat for shorebirds during the breeding, migration, and over-wintering seasons (Brown *et al.* 2000). These same beaches often are attractive to humans for recreation (Maguire *et al.* 2011), residential or commercial activity (Brown *et al.* 2010) and, in many areas, human use is intensive (De Ruyck *et al.* 1997). Human use of beaches can result in physical destruction of shorebird nests and young (Dowling & Weston 1999, Ruhlen *et al.* 2003), displacement of shorebirds from key nesting, foraging, and chick-rearing habitats (Lafferty 2001), and disruption or alteration of adult or parent-chick behaviors (McGowan & Simons 2006, Weston & Elgar 2007). Humans may introduce additional threats to shorebirds by altering the physical structure of the habitat or the native predator community (Schlacher *et al.* 2007).

While humans have the capacity to harm shorebirds, they also have the ability to protect them. This can be done using a variety of methods, but most frequently by restricting human access to important shorebird areas, either through voluntary compliance or through regulation or legislation (USFWS 1994, Lafferty *et al.* 2006). Restrictions may include human exclusion zones, prohibition of recreation known to negatively impact shorebirds (e.g., all-terrain vehicle use) or increased enforcement of existing regulations (e.g., dog leash laws; USFWS 1994, Burger 1995). Even in situations where shorebirds and their habitats are legally protected, the effectiveness of protection measures relies upon public support and high rates of compliance with restrictions (Dowling & Weston 1999, Williams *et al.* 2009, Jorgensen & Brown 2014). Unfortunately, restricting recreation for the benefit of shorebirds may foment negative attitudes toward shorebirds and result in conflicts (Panzar 2013, Harmon 2014). Thus, to be successful, shorebird managers must address challenges pertaining to both the ecological and human components of the environment. In some settings, the challenges associated with humans are the greatest barriers to successful

shorebird conservation and management (Maguire *et al.* 2013). Consequently, there is a need for shorebird managers to better integrate human dimensions information into comprehensive conservation and management plans.

Human dimensions studies focused on shorebirds are relatively recent (Bridson 2000, Antos *et al.* 2006, Williams *et al.* 2009, Ormsby & Forys 2010, van Polanen Petel & Bunce 2012, Burger & Niles 2013, Maguire *et al.* 2013, Jorgensen & Brown 2014, 2015, Ramsdell *et al.* 2016). These studies have focused on specific aspects of the social environment including evaluating education campaigns (Ormsby & Forys 2010), evaluating awareness and attitudes (Antos *et al.* 2006, van Polanen Petel & Bunce 2012, Jorgensen & Brown 2015), assessing human and bird response to beach closures (Burger & Niles 2013, Maguire *et al.* 2013), assessing the attitudes and motivations of dog owners (Bridson 2000, Williams *et al.* 2009, Jorgensen & Brown 2014), and evaluating incentive payments in private lands conservation (Ramsdell *et al.* 2016). While informative and useful, these studies generally lack standardized approaches or conceptual frameworks which would broaden their applicability. This is particularly true regarding understanding the processes and mechanisms which influence attitudes and behaviors towards shorebirds and shorebird protections.

Acceptance capacity refers to the limits to which people will accept or tolerate the presence of wildlife and is defined as the maximum wildlife population size humans are willing to accept in an area (Decker & Purdy 1988, Carpenter *et al.* 2000). Acceptance capacity results from real or perceived consequences of positive or negative impacts caused by the presence of wildlife (Riley *et al.* 2002). The concept has most frequently been applied to concerns related to the presence of large carnivores (Organ & Ellingwood 2000, Riley & Decker 2000) and ungulates (Lischka *et al.* 2008), but it has the potential to be useful in other situations. In beach settings where habitat is limited and subject to crowding (De Ruyck *et al.* 1997), acceptance capacity towards shorebirds may conflict with the implementation of management actions intended to protect shorebirds. Discrepancies between acceptance capacity and management objectives may lead to conflicts between people (e.g., visitors, home or business owners) and regulatory agencies (Decker & Purdy 1988) with the potential for unfortunate consequences to shorebirds and humans alike.

Visitors, shorebirds, and protection measures may occur in close proximity and some of the measures may restrict human recreational activity. Wildlife is valued (Wagner & Seal 1992) and people generally support wildlife conservation, but their support is influenced, at least in part, by their own positive or negative experiences with wildlife (Harcourt *et al.* 1986, Mankin *et al.* 1999). Lack of support toward wildlife conservation and protection generally results from negative experiences, which fall into three categories (Wagner & Seal 1992, Riley & Decker 2000, Zinn *et al.* 2000, Lischka *et al.* 2008, Maguire *et al.* 2013): physical harm, economic cost, and inconvenience. The relative importance of the three categories influencing acceptance capacity will differ based on the wildlife species and individuals involved (Zinn *et al.* 2000, Riley *et al.* 2002). In addition to personal experiences, support for wildlife protection may be influenced by an individual's subjective perceptions and values (Zinn *et al.* 2000). Individuals that support various socio-political philosophies may be more or less inclined to support wildlife protections, even if they have no direct negative experiences themselves (Kuh 2011).

Shorebirds are small and docile and cannot physically harm a human, but, if their presence results in real or perceived economic costs or causes inconvenience, there may be low acceptance capacity and little or no support for their protection. Maguire *et al.* (2013) identified inconvenience as the key negative impact experienced by people using urban beaches in Australia where protection measures were implemented for Hooded Plovers *Thinornis cucullatus*; the more inconvenienced visitors felt, the less receptive they were toward Hooded Plover protection. Visitors using beaches in the United States may be inconvenienced and possibly experience economic costs because of the presence of shorebirds protected by the U.S. Endangered Species Act (ESA) as violations of the statute may result in citations and fines.

In this study, we evaluate how recreational use of a public access beach influences impact perceptions and acceptance capacity toward an ESA-protected shorebird, the Piping Plover *Charadrius melodus*, found nesting at a reservoir in western Nebraska, USA. Piping Plovers occur along the Atlantic Coast, Great Lakes, and Great Plains of North America (Elliott-Smith & Haig 2004). Piping Plovers routinely nest in anthropogenic environments including public beaches (Elliott-Smith & Haig 2004, Brown *et al.* 2010). They typically lay four eggs in shallow, cup-shaped nests in the sand, incubate the eggs for approximately four weeks, and attend to the precocial chicks for approximately four weeks (Elliott-Smith & Haig 2004). We hypothesize that impact perceptions, attitudes, and ultimately acceptance capacity towards protecting Piping Plovers will be affected by the frequency and type of recreational activities in which visitors engage.

METHODS

Study area

Our study took place at Lake McConaughy, Keith County, Nebraska, USA, from 18 May to 21 Jul 2015. Lake McConaughy (41°14'09.6"N, 101°44'27.0"W; Fig. 1) is a human-created reservoir formed when Kingsley Dam on the North Platte River was closed in 1941 (CNPPID 2009). The dam supports a hydroelectric power generating facility, operated under the Federal Energy Regulatory Commission (FERC), under license No. 1417 issued in 1998 (CNPPID 2009). This operating license requires the Central Nebraska Public Power and Irrigation District (CNPPID) to manage and protect threatened and endangered species listed by the ESA and to provide recreational opportunities to the public (CNPPID 2009).

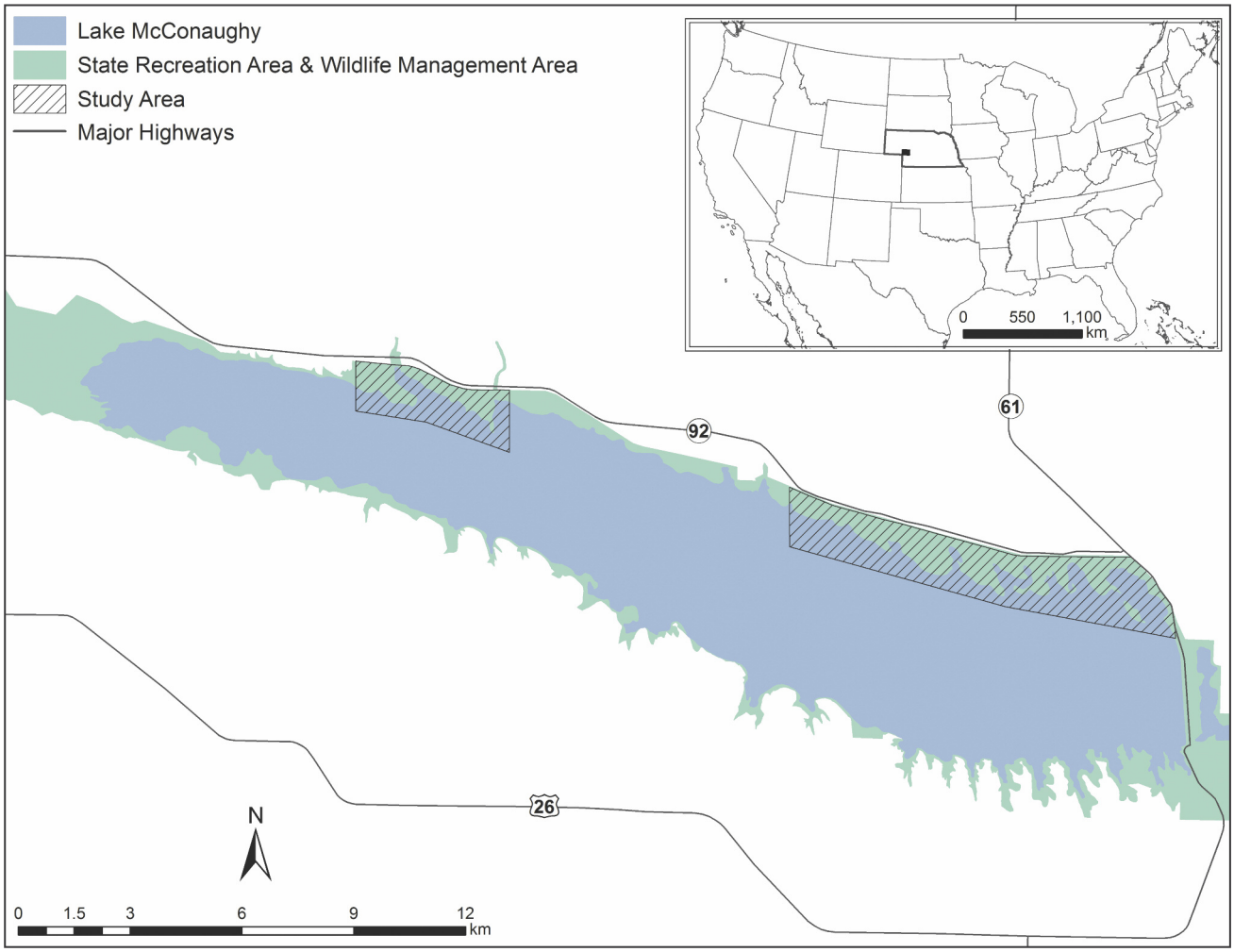

Fig. 1. Location of Lake McConaughy and the State Recreation Area, Keith County, Nebraska, USA, and the study area.

Lake McConaughy is 35 km long and is ringed by white sandy beaches that are attractive to visitors and nesting Piping Plovers. Piping Plovers nest on open sand beaches, which are also open to and used by humans for recreation. The amount of beach area used by both nesting plovers and visitors is variable and is dependent on lake water levels, which are determined by dam releases and inflows. CNPPID protects Piping Plover nests by creating human exclusion zones around them. Human recreational use of Lake McConaughy can be intensive, with more than one million people visiting the recreation area in recent years (Nebraska Game & Parks Commission, unpubl. data). Additional details are presented in Jorgensen & Brown (2014, 2015).

Interview questions and field methods

Our overall approach was similar to Jorgensen & Brown (2015), but here we build upon the earlier study by developing questions that identify impacts that influence visitors' acceptance of Piping Plovers. We surveyed visitors by conducting personal interviews on beaches at Lake McConaughy from 18 May to 21 Jul 2015 during the Piping Plover breeding season. In addition to acquiring basic demographic information (sex, location of primary residence, and age), we asked each respondent the number of visits they make to Lake McConaughy during the summer (May–Aug) each year. We also provided a list of popular recreation activities and asked respondents to identify the primary activities they engaged in while at Lake McConaughy. Primary recreation activities included fishing, boating, camping, swimming, and socializing with friends and/or family. Finally, we asked respondents whether or not a dog accompanied them to Lake McConaughy.

To determine visitor awareness about Piping Plovers and their protected status, we asked survey respondents (a) if Piping Plovers are found at Lake McConaughy and (b) if state and federal endangered species laws protect Piping Plovers. Once respondents had answered these questions, our technicians provided information about Piping Plovers and their protection at Lake McConaughy. Thus, all respondents were aware of Piping Plovers' presence and their status for the remaining questions of the survey.

To determine general support for protecting Piping Plovers, we asked respondents whether Piping Plovers should be protected at Lake McConaughy during the nesting season (PROTECT). Respondents provided

responses on a scale of one to five (Likert 1931); the ranking values meant (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree. Using the same one to five scale, we asked respondents whether the presence of Piping Plovers on the beaches at Lake McConaughy was an inconvenience to them (INCONVEN). Finally, to evaluate which negative and positive impacts resulting from the presence of Piping Plovers might affect attitudes, we provided respondents with a series of statements about their interactions with Piping Plovers at Lake McConaughy. Respondents provided responses on a scale of one to five (Likert 1931); the ranking values were (1) not at all, (2) a little, (3) neutral, (4) somewhat, and (5) a great deal. Statements focused on positive impacts included (a) feel connected to nature (NATURE), (b) feel good an endangered species is being protected (ENDANGER), and (c) feel good that humans will not harm the birds, eggs, nests and chicks (NOHARM). Statements focused on negative impacts included (a) worry about beach crowding (CROWD), (b) worry about being ticketed for intentionally or unintentionally harming Piping Plovers (TICKET), and (c) worry about areas being fenced off or closed to protect Piping Plovers (FENCED). Statements focused on socio-political values included (a) worry about the federal government telling local decision-makers how to manage the beach (FEDGOV) and (b) worry that the needs of Piping Plovers are being prioritized over the needs of humans (PEOPLE).

Analyses

We summarized overall results and compared responses to attitude questions between visitors that disagreed (responses of 1 and 2), were neutral (response of 3), or agreed (responses of 4 and 5) with the statement that Piping Plovers should be protected.

Table 1. Summary of personal interview survey responses. Unless otherwise noted, means are presented ± 1 SE.

Question	*n*	% all respondents
% of respondents male	415	50.12
Age	415	42.12 ± 0.68
Estimated number of annual visits to Lake McConaughy?	409	8.00 ± 0.69
Dogs with them at Lake McConaughy (% yes)	415	39.04
Primary recreation activity – fishing (% yes)	415	19.52
Primary recreation activity – camping (% yes)	415	53.49
Primary recreation activity – boating (% yes)	415	29.64
Primary recreation activity – swimming (% yes)	415	22.65
Primary recreation activity – socializing with friends (% yes)	415	20.72
Are Piping Plovers found at Lake McConaughy? (% yes)	415	49.16
Are Piping Plovers protected by state and federal endangered species laws? (% yes)	415	48.92
Piping Plover should be protected at Lake McConaughy during the nesting season [PROTECT]	415	4.23 ± 0.05
The presence of Piping Plovers on the beaches at Lake McConaughy is an inconvenience to me [INCONVEN]	415	1.58 ± 0.06
Seeing Piping Plovers protected on the beaches at Lake McConaughy make me:		
A) Feel connected to nature [NATURE]	412	3.18 ± 0.08
B) Worry about beach crowding [CROWD]	411	3.47 ± 0.08
C) Feel good an endangered species is being protected [ENDANGER]	414	4.42 ± 0.05
D) Worry about the federal government telling local decision-makers how to manage the beach [FEDGOV]	412	3.61 ± 0.08
E) Feel good the birds and their eggs, nests and chicks will not be harmed by humans [NOHARM]	409	4.33 ± 0.06
F) Worry the needs of animals are being prioritized over the needs of people [PEOPLE]	413	2.07 ± 0.07
G) Worry about being ticketed for intentionally or unintentionally harming the species [TICKET]	413	1.37 ± 0.05
H) Worry about areas being fenced off or closed to protect Piping Plovers [FENCED]	414	1.72 ± 0.06

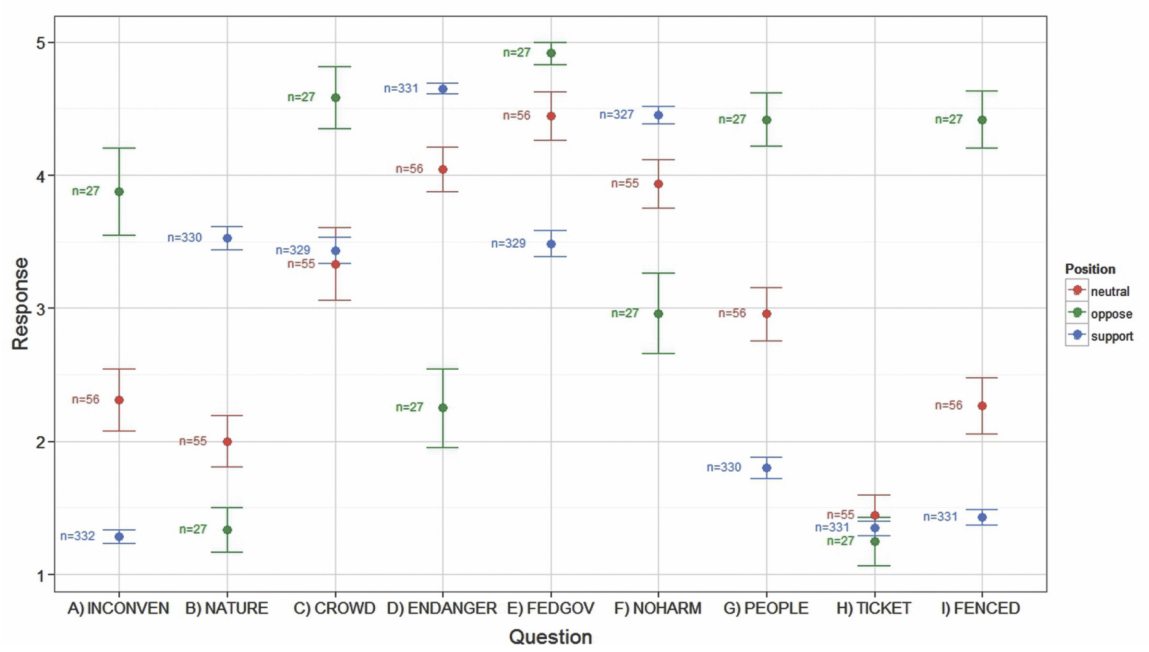

Fig. 2. Mean (± SE; Likert Scale) responses to Piping Plover impact statements separated by attitude (support, neutral or oppose) toward protecting Piping Plovers at Lake McConaughy. Visitors who oppose protecting Piping Plovers felt more inconvenienced and were more worried about beach crowding, role of the federal government in decision-making, areas of the beach being fenced or closed, and the needs of birds prioritized over the needs of humans. Visitors who support protecting Piping Plovers felt connected to nature and felt good that an endangered species was being protected, and birds, their eggs or chicks would not be harmed by humans. None of the groups were worried about being ticketed for violations of wildlife protection laws. Complete questions are found in Table 1.

We used cumulative logit models (Agresti 2007) to determine the relative importance of a suite of variables in a set of candidate models evaluating attitudes and impact statements. We used (1) primary recreation activities (fishing, boating, camping, swimming and socializing), (2) accompanied by a dog, (3) number of annual visits during the nesting season, and (4) the visitors' sex, age and awareness of the presence of Piping Plovers at Lake McConaughy as variables in a set of a priori models. We included sex and age of the visitor in our models because previous research (Jorgensen & Brown 2015) showed those variables were associated, albeit weakly, with attitudes toward Piping Plovers; that same study showed location of principal residence was not associated with attitudes towards Piping Plovers. We included awareness (yes or no) of Piping Plovers at Lake McConaughy in our models because awareness of a protected species in a beach setting has been associated with negative attitudes toward that species (Maguire *et al.* 2013). Because of the skewed distribution of responses for most questions, only a small proportion (<25 overall responses) registered responses of 2 and/or 4. We combined negative (1 and 2) and positive (4 and 5) responses on the 5-point Likert scale into agree and disagree values. A response of three was considered neutral.

Once the cumulative logit models were constructed, we used Akaike's Information Criterion (AIC_c) and model weights (w_i) to select the best-fitting model(s) (Burnham & Anderson 2002) and *z*-statistics to determine whether the maximum likelihood parameter estimates for the top model differed from zero. We provide parameter estimates which show how the log odds differ for each response value (Likert scale 1–2 or 4–5) compared to the response of 3 (neutral) for variable(s) in the best-fitting model. Finally we provide log odds ratios of the probability for each response value (Likert scale 1–2 or 4–5) compared to the response of 3 (neutral) for variable(s) by exponentiating coefficients from the best-fitting model.

Models with the lowest AIC_c value are considered the best fitting and models with $\Delta AIC \leq 2$ are considered to have significant support. The top three models or all models with $\Delta AIC \leq 2$ are provided. All statistical analyses were performed in Program R 3.1.3 (R Development Core Team 2014).

RESULTS

We surveyed 415 visitors with nearly equal numbers of males ($n = 208$) and females ($n = 207$) interviewed (Table 1). Respondent age ranged from 19 to 85. Over half (53.5%) of respondents identified camping as their primary recreation activity, followed in popularity by boating (29.6%), swimming (22.7%), socializing with friends and/or family (20.7%), and fishing (19.5%). Dogs were common beach companions, accompanying many (39.0%) respondents. Slightly less than half (49.2%) of all respondents stated they were aware Piping Plovers were present at Lake McConaughy and 48.9% of visitors were aware of Piping Plovers' protected status.

Overall, mean response to the question PROTECT was 4.23 ± 0.05, indicating strong support (plovers should be protected). Mean response to the question INCONVEN was 1.58 ± 0.06, indicating little support (plovers were not an inconvenience). Visitors strongly supported impact statements ENDANGER (4.42 ± 0.05) and NOHARM (4.33 ± 0.06), indicating they support plover protection. Visitors supported slightly above neutral the impact statements CROWD (3.47 ± 0.08) and FEDGOV (3.61 ± 0.08), suggesting some, but no substantive, concern that beaches would become overcrowded or that the federal government was overreaching. Visitors' response to the statement NATURE was close to neutral (3.18 ± 0.08). Visitors did not support statements PEOPLE (2.07 ± 0.07), TICKET (1.37 ± 0.05) or FENCED (1.72 ± 0.06), suggesting little concern that Piping Plovers are being prioritized over humans, or that humans are being over ticketed or fenced out of beach areas. See Table 1 for details.

Responses to impact statements differed depending on whether a visitor opposed, was neutral, or supported protecting Piping Plovers at Lake McConaughy (Fig. 2). Visitors who *opposed* protecting Piping Plovers felt more inconvenienced by the birds (3.88 ± 0.33) and were more worried about beach crowding (4.58 ± 0.23), the role of the federal government in decision-making (4.92 ± 0.08), areas of the beach being fenced or closed (4.43 ± 0.20) and the needs of birds being prioritized over the needs of people (4.42 ± 0.20). Visitors who *supported* protecting Piping Plovers felt connected to nature (3.53 ± 0.09), felt good that an endangered species was being protected (4.65 ± 0.04), and that humans would not harm the birds, eggs, or chicks (4.45 ± 0.06). Neither of the groups were worried about being ticketed for their behavior regarding Piping Plover protection measures.

Akaike's Information Criterion (AIC_c) indicated the relative importance of a suite of variables in a set of candidate cumulative logit models evaluating attitudes and impact statements. The top model (lowest AIC_c) for the question PROTECT included the variables plover awareness and socializing (Table 2). The estimated odds of a visitor indicating support for Piping Plover protections was 2.52 times greater than the odds for a neutral response when the visitor indicated socializing with friends was a primary recreation activity. The top model for the impact statement NATURE included plover awareness and sex (Table 2). The estimated odds of a visitor indicating they do not feel connected to nature when seeing a Piping Plover was 1.78 times greater than the odds for a neutral response when the visitor was male (Table 3). The estimated odds of a visitor indicating they do not feel connected to nature was 2.32 times greater than the odds for a neutral response when the visitor was aware of the presence of Piping Plovers.

The top model for the impact statement FEDGOV included respondent age and boating as a recreational activity (Table 2). The estimated odds of a visitor disagreeing or agreeing with the statement FEDGOV were, respectively, 1.03 and 1.05 times greater than the odds for a neutral response for each unit increase in the respondent's age (Table 3). Older respondents were more likely to express an opinion regarding plovers and were slightly more likely to be worried about the federal government's role in decision-making than were younger respondents (Table 3).

The top model for the statement PEOPLE included the variables plover awareness and boating (Table 2). The estimated odds of a visitor indicating they agreed with the statement PEOPLE was 4.10 times greater than the odds for a neutral response when the visitor was aware of the presence of Piping Plovers (Table 3). Our model selection procedure for the statement FENCED showed a model that included plover awareness and respondent age had the lowest AIC_c (Table 2). The estimated odds of a visitor disagreeing with the statement FENCED was 0.97 times greater than the odds for a neutral response for each unit increase in the respondent's age (Table 3). The estimated odds of a visitor agreeing with the statement FENCED was 5.53 times greater than the odds for a neutral response when the visitor was aware of the presence of Piping Plovers. Model selection for the statement TICKET produced a top model that included plover awareness and respondent sex (Table 2). None of variables received statistically significant support, although sex was barely outside of our significance level ($P = 0.06$). Our model selection procedure for the statement NOHARM showed an intercept-only model had the lowest AIC_c (Table 2).

Model selection for the questions INCONVEN and statements CROWD and ENDANGER showed a model that included plover awareness had the lowest AIC_c values (Table 2). The estimated odds of a visitor indicating they were inconvenienced by Piping Plover protections was 16.01 times greater than the odds for a neutral response when the visitor indicated they were aware of Piping Plover presence at Lake McConaughy (Table 3). The estimated odds of a visitor indicating disagreement with the statement about feeling good an endangered species was being protected was 4.20 times greater than the odds for a neutral response when the visitor was aware of the presence of Piping Plovers (Table 3). None of variables in the top model for CROWD received statistically significant support (Table 3).

DISCUSSION

Overall acceptance capacity towards Piping Plovers at Lake McConaughy does not appear to be influenced by acute or real-time negative impacts caused by the presence of plovers or protection measures associated with them. Our results differ from Maguire *et al.* (2013) who showed visitors with lower awareness of the birds, who used the beach more frequently, and had dogs accompanying them, were more likely to feel more inconvenienced and exhibit a lower acceptance capacity. This difference might be explained by differences in the types of management restrictions being implemented in the two areas. Piping Plover protections, as currently implemented at Lake

Table 2. Top model based on our selection procedure for attitude questions towards Piping Plovers.

Model	AIC_c	ΔAIC	W_i
1) Piping Plover should be protected at Lake McConaughy during the nesting season [PROTECT]			
Plover awareness + socializing	520.76	–	0.21
Plover awareness + boating	522.45	1.69	0.09
Socializing	522.62	1.86	0.08
Plover awareness	522.67	1.91	0.08
2) The presence of Piping Plover on the beaches of Lake McConaughy is an inconvenience to me [INCONVEN]			
Plover awareness	407.63	–	0.25
Plover awareness + boating	407.64	0.01	0.25
Plover awareness + sex	407.88	0.25	0.22
3) Seeing Piping Plovers protected on the beaches at Lake McConaughy makes me:			
a) Feel connected to nature [NATURE]			
Plover awareness + sex	831.59	–	0.92
Sex + socializing	838.35	6.76	0.03
Sex + age	839.07	7.48	0.02
b) Worry about beach crowding [CROWD]			
Plover awareness	687.37	–	0.18
Plover awareness + sex	687.82	0.46	0.14
Plover awareness + socializing	688.50	1.14	0.10
Plover awareness + boating	688.57	1.20	0.09
c) Feel good an endangered species is being protected ENDANGER]			
Plover awareness	366.70	–	0.24
Plover awareness + dog owner	368.01	1.31	0.13
Plover awareness + sex	368.08	1.38	0.12
Plover awareness + age	368.39	1.69	0.10
Plover awareness + fishing	368.57	1.87	0.10
d) Worry about the federal government telling local decision-makers how to manage the beach [FEDGOV]			
Age + boating	692.37	–	0.45
Age + socializing	694.40	2.03	0.16
Age	694.44	2.07	0.16
e) Feel good the birds and their eggs, nests and chicks will not be harmed by humans [NOHARM]			
Intercept only	484.26	–	0.23
Dog owner	484.90	0.64	0.17
Plover awareness	486.64	2.37	0.07
f) Worry the needs of animals are being prioritized over the needs of people [PEOPLE]			
Plover awareness + boating	717.32	–	0.70
Plover awareness	720.66	3.34	0.13
Plover awareness + socializing	722.57	5.25	0.05
g) Worry about being ticketed for intentionally or unintentionally harming the species [TICKET]			
Plover awareness + sex	354.38	–	0.28
Sex + age	355.09	0.71	0.19
Sex + socializing	356.63	2.25	0.09
h) Worry about areas being fenced off or closed to protect Piping Plovers [FENCED]			
Plover awareness + age	582.60	–	0.50
Plover awareness + boating	583.59	0.98	0.31
Plover awareness + camping	587.35	4.75	0.05

McConaughy, do not greatly restrict recreational activities, whereas Hooded Plover protections did restrict recreational activities. However, previous research (Jorgensen & Brown 2015) showed visitors with pre-existing negative attitudes toward plover protection felt more negatively toward the implementation of any additional recreation restrictions intended to protect Piping Plovers.

These results do not support our hypothesis that participation in certain recreational activities is more likely to result in negative attitudes. Formation of negative attitudes is apparently a more complex process influenced by a combination of experiences and variables including personal beliefs and values. Focusing specifically on certain recreational activities may be overly simple, as a large proportion of visitors in our study were engaged in several types of recreational activities. Visitors possessing negative attitudes towards Piping Plovers represented a relatively small percentage (6.5%) of our total sample. However, if we extrapolate this relatively small percentage to the total number of annual visitors to Lake McConaughy (doubled over the past 25 years and currently estimated at 1 million per year; NGPC unpubl. data) then the population with negative attitudes toward Piping Plovers at Lake McConaughy could be more than 65,000 people.

Awareness of nesting Piping Plovers at Lake McConaughy was the most important variable influencing responses to our survey questions. Awareness of Piping Plovers was strongly associated with perceived negative impacts caused by Piping Plovers and their associated protection measures; visitors with more negative attitudes generally possessed lower acceptance capacity toward the birds. Visitors were 16 times more likely to indicate that they were inconvenienced by Piping Plover protections when they were aware of Piping Plover presence at Lake McConaughy. Thus, there is a negative side to awareness — the danger that some visitors will only feel inconvenienced by the plovers when they become aware of them and their protected status. However, the association between awareness of Piping Plovers and negative attitudes towards the birds needs to be considered within the context of the awareness of all visitors. Slightly more than half of all the visitors we interviewed were previously unaware of the presence of Piping Plovers and their protected status prior to completing our survey. Individuals unaware of the presence of Piping Plovers or their status strongly supported (4.62 ± 0.07) protecting the species. Previous research (Jorgensen & Brown 2015) showed awareness of Piping Plovers and their protected status increased with (1) increased respondent age, (2) increased number of annual visits to the lake, (3) respondent sex (male), and (4) local residents rather than those whose primary residence was located some distance away. Based on these results, we conclude that awareness of and negative attitudes towards Piping Plovers develop concurrently through experiences in which visitors interact with the birds and the associated

Table 3. Estimates of maximum-likelihood parameters and the significant deviation from 0 for the best-fitting model describing the probability of responses to awareness questions.

Parameter	Estimate ± SE	*z*-value	*P* > *z*
1) Piping Plover should be protected at Lake McConaughy during the nesting season [PROTECT]			
Socializing (Yes) – agree	0.92 ± 0.45	2.04	0.04
2) The presence of Piping Plover on the beaches of Lake McConaughy is an inconvenience to me [INCONVEN]			
Plover awareness (Yes) – agree	2.77 ± 0.72	3.83	<0.001
3) Seeing Piping Plovers protected on the beaches at Lake McConaughy make me			
a) Feel connected to nature [NATURE]			
Sex (male) – disagree	0.58 ± 0.29	2.01	< 0.001
Sex (male) – agree	–0.98 ± 0.25	–3.90	< 0.001
Plover awareness (Yes) – disagree	0.84 ± 0.28	3.03	0.002
c) Feel good an endangered species is being protected [ENDANGER]			
Plover awareness (Yes) – disagree	1.44 ± 0.44	2.28	0.02
d) Worry about the federal government telling local decision-makers how to manage the beach [FEDGOV]			
Age (disagree)	0.03 ± 0.63	1.95	0.05
Age (agree)	0.07 ± 0.59	2.92	<0.001
f) Worry the needs of animals are being prioritized over the needs of people [PEOPLE]			
Plover awareness (Yes) – agree	1.41 ± 0.36	3.91	<0.001
h) Worry about areas being fenced off or closed to protect Piping Plovers [FENCED]			
Age (disagree)	–0.03 ± 0.41	–2.61	<0.01
Plover awareness (Yes) – agree	1.71 ± 0.46	3.72	<0.001

protection measures and recreation restrictions. Education programs tailored to new or recent visitors may positively influence their developing attitudes toward Piping Plovers.

A common challenge for shorebird management in beach settings throughout the world is increasing human use (De Ruyck *et al.* 1997). Managers and regulatory agencies responsible for finding a balance between the needs of people and shorebirds should consider the concept of social carrying capacity in their policies, in addition to wildlife carrying capacity. Social carrying capacity refers to the number (or density) of humans an area can support before those numbers (or densities) intrude upon the perceived quality of the area (Brotherton 1973, Manning 1997). Public beaches receive intensive use by humans and can support relatively high densities of people compared to other public lands before their perceived value is diminished (Roca *et al.* 2008, Oh *et al.* 2010). Nevertheless, unregulated numbers of people using public beaches for recreation can result in undesirable crowding. Crowding can be intensified if portions of beaches are excluded from recreation because of the presence of protected wildlife. Preemptively identifying the social carrying capacity of beaches and its relationship with acceptance capacity towards shorebirds and other wildlife will allow managers to proactively manage beaches for shorebirds.

The conservation of shorebirds will continue to occur in coupled human-wildlife ecosystems as human use of coastal and inland beaches intensifies. The use of human dimensions frameworks in research and management will help managers address human-shorebird conflicts and implement successful protection programs. Wildlife acceptance capacity is a scalable and flexible concept which can be applied to any anthropogenic environment where shorebirds occur. Additional research should focus on identifying the variables which modify or regulate perceptions and acceptance capacity towards shorebirds and other wildlife. Perception and acceptance vary from place to place and over time and may be influenced by changes in (1) wildlife numbers, (2) positive and negative impacts associated with wildlife, (3) changing subjective values, beliefs and perceptions, and (4) other changes in the environment. Our study serves as an important baseline which can be used to determine whether awareness, impact perceptions, and acceptance capacity at this one site evolve over time.

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