

Information Needed For Coastal Management: Perceptions Of Research And Protection Of Shorebirds On A Coastal Beach Are Influenced By Visitor Type, Age And Gender

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Abstract

Protection of shorebirds along coasts where they congregate during migration is an important conservation goal, yet little is known about the reasons that attract people to beaches. Data on perceptions can be used to develop and implement educational and conservation programs, enhancing both visitor experiences and shorebird survival. Urbanization is encroaching on many beaches and estuaries that are necessary stopover sites for migrant birds. This study examines perceptions of visitors at 9 Delaware Bay beaches during the critical northward shorebird migration using interviews (N = 279). We examine the hypothesis that visitors come to Delaware Bay beaches mainly to see the shorebirds (including Red Knots, *Calidris canutus rufa*) and the crabs whose eggs sustain the shorebirds. Only 60 % of visitors were there primarily to see the shorebirds and crabs, the rest were there for the scenery, tranquility, fishing, or other recreation activities, despite access restrictions. Even when asked what makes the beach attractive, from 17 % (people interested in birds) to 62 % (people interested in crabs) listed tranquility and scenery. Older people rated the importance of research and protection of shorebirds (and crabs) higher than younger people. Over 40 % did not want to see any changes to beaches, while 28 % wanted to see improvements, and 24 % wanted to see more restoration and conservation. Nearly 60% said these beaches would be less attractive if there were more people. These perceptions can aid managers, conservationists and communities improve beaches for both migratory shorebirds and human use.

Introduction

One of the key questions in understanding ecosystem dynamics in heavily populated urban and suburban areas is the effect of human activities on wildlife. Addressing how wildlife can co-exist within a matrix of heavily developed and wild areas is critical to managing both threatened and endangered species, as well as allowing people to use and enjoy these habitats. While sandy beaches support important human activities such as recreation and fishing, they also support ecological communities. With increasing use of coastal environments by people coming from nearby urban and suburban centers, habitat for migrating shorebirds and other coastal species are decreasing in quantity and quality (Foster et al. 2013). Shorebirds are one of the most endangered groups of birds in the world (Morrison et al. 2001, 2007; Andres et al. 2013), and developing conservation plans that incorporate the needs of people and wildlife is an important societal goal (Colwell 2010). People and researchers are increasingly aware that protecting green places within urban and suburban environments is particularly important for human health and well-being (Labib et al. 2020).

Migrant shorebirds have to spend sufficient time to build up fat reserves to make long journeys (Brown et al. 2001, 2017; Baker et al. 2004, 2013), and some human activities reduce the time they can devote to foraging (Burger 1986, Goss-Custard et al. 2006; Martin et al. 2015). The lack of suitable habitats, without human disturbance, is becoming a more severe problem with sea level rise and decreasing amounts of available mudflats (Galbraith et al. 2002, 2014). Various management methods have been implemented to reduce human disturbance on foraging shorebirds during critical stopover periods, including restricting human access to key foraging beaches (with fencing or patrols), having voluntary minimum approach distances, and employing beach stewards to protect sensitive beaches (Brown et al. 2001; Burger and Niles 2013a, b, 2014; Koch and Paton 2014).

In previous work along the Atlantic coast of North America, we found that voluntary avoidance of beaches where shorebirds were foraging was not effective (Burger and Niles 2013a, b). Since the early 2000s, New Jersey has restricted access on critical Delaware Bay beaches, used signage and fencing, and implemented a stewardship program to educate the public and keep people and dogs from these beaches (Burger and Dey, 2022; Dey et al. 2020). Management is most effective in collaboration with local communities and people who use the beach ecosystem (Burger and Niles 2017; Burger and Tsipoura 2019). Understanding how and why people want to visit beaches during peak shorebird migration periods is critical to improving management, particularly along beaches used extensively by people.

With increasing use of coastal environments by people coming from nearby urban and suburban centers, habitats for migrating shorebirds and other coastal species are decreasing in quantity and quality. Migrant shorebirds have to spend sufficient time to build up fuel reserves to make long-distance flights, and human disturbance reduces the time they can devote to foraging (Burger, 1986; Goss-Custard et al. 2006). For example, some northbound shorebirds (i.e. red knots *Calidris canutus rufa*) can arrive in Delaware Bay with no fat reserves, and must double their weight in 2 – 3 weeks to successfully reach their sub-Arctic breeding grounds (Baker et al. 2004, 2013; Duijins et al. 2017). Declines of shorebirds migrating through Delaware Bay has been attributed to lack of available eggs of horseshoe crabs (*Limulus polyphemus*) (Niles et al. 2008, 2009; McGowan et al. 2011). Overexploitation of horseshoe crabs for bait means shorebird migrants are energy-stressed (USFWS 2014a, b). The shorebird conservation program has been very successful in that management, stewardship, and the restoration of beaches in New Jersey has contributed to attracting the majority of the red knots that migrate through Delaware Bay to the New Jersey side of the Bay (Dey et al. 2020). This trend started in 2012, and has continued since that time; prior to this time no such trend was obvious. The program, however, requires continued funding and expansion to further improve habitat and the overall health of the Delaware Bay ecosystem.

The present study was designed to examine the perceptions, concerns, and evaluations of visitors to the Delaware Bay beaches in May and early June during the massive shorebird migration. Although it was generally assumed that most people came to these beaches to see the foraging shorebirds and the spawning horseshoe crabs, one study goal was to determine whether this was true. The main objectives were to determine: 1) visitor type, 2) support for research and protection of ecological resources, 3) how the beach could be improved, and 4) conservation suggestions. The intent was to examine why people came, whether they supported research and protection, and how to improve the beach while being able to conserve the shorebird-horseshoe crab phenomena.

While the data in this study are from 9 beaches along the Delaware Bay shore, the perceptions, concerns and evaluations can aid managers in making decisions about protection of coastal ecosystems and can serve as a model for similar studies in other coastal areas. The dire plight of migrant shorebirds is a global issue, and many of the stopover areas are near urban and suburban environments (Morrison et al. 2001; Andres et al. 2013) attracting high visitation rates. The issues are particularly relevant to the Atlantic and Gulf coasts of North America, which hosts significant populations of migrating shorebirds and some populations of federally threatened nesting shorebirds, as well as dwindling populations of nesting colonial birds (Burger and Gochfeld 2016).

Methods

Our overall protocol was to interview people visiting Delaware Bay (New Jersey) during the spring shorebird migration period about their activities, perceptions, concerns, and ratings of ecological and ecocultural resources. All interviews were in person, with appropriate Covid protocols and Rutgers University Institutional Review Board (IRB # E-16-123).

Study areas

Delaware Bay, located along the Atlantic coast of North America, is bordered on the northwestern side by Delaware, and on the southeastern side by New Jersey. Most of the New Jersey side is sparsely populated, except for the lower portion leading to Cape May. Horseshoe crabs spawn on both sides of the Bay in May and June, and Delaware Bay has the largest populations of this species along the Atlantic coast (ASMFC 1998, 2009). Migrating shorebirds forage on both sides of the bay, although the NJ beaches have more creeks with shoals that attracts crab spawning. Salt marshes border many of the beaches, although other beaches are bordered by bulkheads or beach communities with houses and roads. Some of the southern NJ beaches have oyster aquaculture in the intertidal zone. The beaches are generally accessible by suburban streets or by sandy and dirt roads built through salt marshes. Most beaches had beach stewards in attendance for some of the time. Their dual task is to prevent access to the beach by people and dogs, and to provide education. The overall protocol was to interview visitors to 9 beaches on the New Jersey side from Villas Beach to Fortescue Beach (Fig. 1).

Protocol

People were interviewed at 9 Delaware Bay beaches where horseshoe crabs spawn and shorebirds forage. Interviews were conducted by trained personnel after completion of pilot interviews. From 10 May until 10 June, 279 people were interviewed. Interviews were conducted from 7 am to dusk every day, although visitation rates were not constant throughout the period. Interviewers visited the beaches in a random fashion, usually spending 3-4 hours at one beach before moving to another, pre-determined the night before to achieve coverage of the different beaches, while optimizing the number of people interviewed. Interviews were conducted every day during both weekdays and weekends. Two people were dedicated full-time to this study.

The access location for viewing shorebirds or crabs was normally a section of beach at the end of a road that was slightly wider than the access road itself. People could come down to the access space and look either up or down the beach for shorebirds. In most cases, people could go down to the water's edge and see crabs from a close distance. Shorebirds sometimes fed very close to the string and post fence, or could be foraging way out on shoals and sandbars. Sometimes no shorebirds were in evidence, other times flocks were examined by serious birders with telescopes.

Once an interviewer arrived at a beach, they asked the first person who approached the beach if they would be willing to be interviewed. Since many of the access points are at the end of a paved road, it was easy to determine who had just arrived. The interviewer identified themselves as from American Littoral Society and Rutgers University, explained that their answers would be confidential, that interviewees would not be

identified in the survey and the data would be combined into categories. Upon completion of that interview, the next new person to arrive at the beach was interviewed. Because of Covid, interviewers were fully vaccinated and maintained a suitable “outdoor” distance when interviewing people. Refusal rate was low (less than 8%) and was largely due to time constraints or presence of children. People who were interviewed are hereafter referred to as interviewees.

The interview form had questions about demographics (age, gender, ethnicity, number of people in the group), home location, number of times they came to Delaware Bay beaches per year, and number of years they had been coming to Delaware Bay, and why they came to the beach. Three types of questions were asked: 1) open-ended questions where people could say whatever they wanted, 2) choice question, and 3) rating questions using a Likert Scale (of 1-5, where 1 is the lowest value and 5 is the highest value). The open-ended question included why they came, what might make the beach more (or less) attractive, and what conservation measures they would like to see. The choice questions asked people to select what was their primary reason (and 2nd and 3rd reasons) for coming to this beach from a list of options. The rating questions asked people to rate the importance of protection and research on shorebirds, crabs and fishing. Open-ended questions were asked early during the interview to elicit free and unbiased answers. Rating questions of a list provided were placed later in the questionnaire. Demographics and open-ended questions were asked first, followed by choice and rating questions. The interview survey form was similar to other forms used in the past, although the questions themselves differed (Burger and Tsipoura 2019). The open-ended questions were analyzed by putting answers into categories (e.g. walking, running, picking up sea glass were recreation).

The survey form was a page long. The in-person interview required from 15 minutes to 45 minutes, depending upon whether people wanted to talk about the issues or ask questions. Questions were answered at the end of the interview to prevent bias in the answering of latter questions. People often wanted to discuss the shorebirds, ask questions about crabs or the crab harvest, and discuss the health of the Bay in general. Some wanted to express frustration that they could not get closer to the shorebirds or crabs, and this provided an opportunity to discuss the effects of human activities on shorebirds. Although beach stewards were present at some study sites, only 40% of interviewees had ever spoken to a steward. More details on interviewee response to stewards can be found in Burger et al. (in press). Further, 63% of the interviews were completed from 7AM to 1 PM, and the rest were completed from 1PM to 8 PM.

Means and standard deviations are given in the text unless otherwise mentioned. Differences among categories were determined by Chi Square tests where appropriate, and we distinguished the differences using Duncan Test (SAS 2020). Correlations were determined by Kendall tau.

Results

Demographics

There were no differences in the gender of the interviewees (47% females, 53% male). The average group size was 2 ± 0.09 . Most people interviewed were alone, with a spouse, or with children. The average age was 54 ± 0.1 years; 8% were under 30 years, 20% were 31 – 45, 31% were 46-60, and 41% were over 60 years. The same

percentage of males and females occurred at all age classes. Most people self-identified as white (81%); others identified as Latin/Hispanic (7%), Black (5%), and Asian (4%); the rest identified as other.

Visitor types and reasons for coming to Delaware Bay beaches

When asked why they came to the beach, most interviewees said they came to the Delaware Bay beaches to see the shorebirds, horseshoe crabs and/or both (58%, Fig. 2). Interviewees were also asked to list their 2nd and 3rd reasons for coming to this beach. The percent of the total interviewees who mention each category of potential reasons for coming (regardless of whether it was their first, second or third choice) was calculated: 77% said it was for shorebirds, while 85% said it was for tranquility and the scenery (Fig. 2). These questions were open-ended, and interviewees could answer whatever they liked. These data indicate that people come for a variety of reasons, and recognize that they do so.

The age distribution, however, varied by visitor type. Most people who came to see the shorebirds, crabs or interactions were older, while people coming for other reasons were younger (Table 1). There were also significant gender differences in why interviewees came to the Delaware Bay beaches ($X^2 = 21.9, P < 0.001$). In general, more males came for recreation and fishing than did females (23% compared to 10%), and more females came to see crabs than did males (13% compared to 2%), although the percentages coming to see shorebirds, or both shorebirds and crabs was similar.

Table 1

Classification of interviewees into 6 types of visitors, and distribution of visitors as a function of age.^b Percents are given for the age classes (e.g. the percent for a given visitor type adds up to 100%).

Visitor Type	Percent of each type	Less than 30 years	30-45 years	46-60 years	Over 60 years
Shorebirds	38	1	17	36	46
Birds and Crabs	15	3	13	24	61
Crabs	5	11	16	16	58
Fish	7	22	56	22	0
Recreation and Other	11	16	37	32	15
Tranquility and Scenery	24	16	22	32	30
a. For percent of each type of visitor, $X^2 = 44.7, df = 5, P > 0.04$.					
b. For age by type of visitor, $X^2 = 49.1, df = 18, P > 0.0001$.					

Only 23% of the interviewees were first time visitors, most (77%) had visited before; there were no significant visitor type differences (Table 2). Most interviewees visited 1-5 times during the year (64%), another 21% visited 6 – 10 times a year, and the rest came more often (usually locals). Many people came to the Bay beaches for several years (mean of 16 ± 1 years). Many interviewees had been coming for 11-20 years, which represents much of the time the shorebird-crab phenomena has been highly publicized in the media. There

were significant differences in whether they went to other beaches and number of visits/year, but not in whether they thought birds or crabs should receive special protection (Table 2).

Table 2

Visitation rates and perceptions of protection for shorebirds and crabs as a function of visitor type for all interviewees (N = 279). Given are the percent of interviewees answering each question.

Visitor Type	Is this your first visit here (% yes)	Go to other beaches to watch birds (% yes)	How many times do you come to these beaches/year (% answering 1-5 days)	Do you think birds should receive special protection (% yes)	Do you think crabs should receive special protection (% yes)
Shorebirds (Knots, birds)(n = 106)	16	90	64	99	90
Shorebirds and crabs (n = 41)	30	97	60	92	83
Horseshoe crabs	25	64	57	92	93
Fish (n = 20)	29	16	72	94	68
Recreation and other (n =31)	24	28	65	80	87
Tranquility and Scenery (n = 67)	29	27	82	95	86
χ^2	4.6 (NS)	92.0 (0.0001)	34 (0.03)	10.3(NS)	9.4 (0.49)

One advantage of open-ended questions is to elicit perceptions or preferences that might not otherwise be apparent. We compared the visitor type (determined by the open-ended question – Why did you come?) with the question - What makes this beach attractive? The two questions are similar and we expected the result to be the same. However, this was not the case (Table 3, $X^2 = 134.7$, $P > 0.0001$). We tallied the first response interviewees gave to the question of attractiveness. In general, many more interviewees mentioned either scenery or tranquility in response to this question (compared to questions about why they came). In Table 3, of the people who said their primary reason for coming to the Delaware Bay beaches was for shorebirds (red knots and birds), only 58% said it was the birds that made it “attractive” to them, and another 17% said it was for tranquility or the scenery. That is, of the total sample of people who said they came for the birds only 58% said birds made the beach attractive, 17% said tranquility and scenery, and the rest said other things.

Table 3

Reasons why interviewees felt the Delaware Bay beaches were attractive as a function of visitor type. They were answering the question – What makes this beach attractive? Given are the percent of each visitor type that listed each of the ecological or eco-cultural resources as the reason for coming to these beaches^a.

Visitor Type	Birds	Birds and crabs	Crabs	Fishing	Recreation and other	Tranquility and scenery
Birds	58	6	7	0	12	17
Birds and crabs	19	19	15	0	17	29
Crabs	0	0	23	0	15	62
Fish	11	0	16	31	10	32
Recreation and Other	20	5	6	4	21	44
Tranquility and Scenery	3	3	3	3	37	51
a. $X^2 = 134,7, P > 0.0001$						

Beach improvements

In the above section, the presence of shorebirds and crabs, and scenery and tranquility were the features that made the Delaware Bay beaches attractive. Interviewees were also asked what would make the beach even more attractive, or less attractive on open-ended questions (Fig. 3). They could comment on anything that occurred to them. Figure 3 provides a summary of the major categories, while Tables 4 and 5 provide more detail for resource managers and planners. Management requires understanding the precise aspects of visitor responses so they can be addressed. Nearly half of the people interviewed said “Leave it alone, don’t change” (41%) or “allow fewer people” (6%), and another 9% said “I don’t know.” Thus, most interviewees liked the Delaware Bay beaches with stewards as they are. Other reasons and responses are shown in Table 4.

Table 4

Responses of interviewees visiting Delaware Bay beaches from 9 May to 5 June, during the migration of shorebirds and the spawning of horseshoe crabs. The Question was – How could this beach be made more attractive? Interviewees (N = 279) could give more than one answer.

Comments from Interviewees	Number	Percent
Fine as it is, don't ruin it, don't develop it	114	41
Allow fewer people	18	6
Improvements		
Have porta-potties/toilets	20	7
Have viewing platforms	19	7
Clean up the trash and debris, and remove graffiti	18	6
Provide more signage, information and brochures	13	5
Provide more beach access	12	4
Provide benches	9	3
Provide more parking (with signs of where to park)	7	3
Restoration/Conservation		
Provide better habitat for knots and more shorebirds	45	16
Provide better habitat for spawning crabs	13	5
Provide better habitat for fish (increase numbers)	7	3
Management		
Make it easier to walk to the beach	6	2
Keep dogs off the beach	4	1
Reduce dredging	1	Less 1
Make me feel welcome	2	1
Get rid of noisy gulls	2	1
Remove crab shells	1	Less 1
Provide places to eat	1	1
More sea glass	1	Less 1
I don't know	26	9

Table 5

Responses of interviewees (N = 279) to the question – What would make these beaches less attractive?
Interviewees (N = 279) could give more than one answer.

Comment	Number	Percent
Nothing, do not change it	21	8
More:		
People	130	47
Development (houses) and commercialization	24	9
Trash	17	6
Bugs	9	3
Fishermen	7	3
Dead crabs on beach ^a	5	2
Dogs on the beach	4	2
Noise and partying	4	2
Sharks	1	Less 1
Fewer:		
Birds	16	6
Protected areas and habitats	10	4
Fewer fish	2	1
Over-regulated (policing,	3	1
Unusual comments:		
Bad weather	1	Less 1
Hard to get too	1	Less 1
Can't walk my dog	1	Less 1
Too many photographers and obnoxious people	1	Less 1
I Don't know	26	9
a. This is actually a misunderstanding. Many of the crabs that people think are dead have been stranded by the tide, their dorsal surface is up to prevent dissiccation, and during the next high tide will move out.		

The constructive answers fell into three categories: actual improvements, restoration and conservation, management, and unusual comments (Table 4). Some interviewees wanted toilets, viewing platforms, cleaning up trash, and providing more signage. In talking to interviewees, many expressed concerns that they did not know where to park, whether it was legal, or where to sit. The greatest number of people, however,

thought there could be better (or more) habitat for knots, shorebirds, and spawning crabs. The restoration and conservation included providing better habitat for birds, crabs and fish.

The second open-ended question about the attractiveness of the Delaware Bay beaches dealt with what would make the beaches less attractive (Fig. 3, Table 5). Nearly half of the interviewees interviewed (56%) said that more people or development would make it less attractive. Again, 8% said do not change it at all. Others were concerned about trash, bugs, dead crabs on the beach dogs, and noise. Ten percent of those interviewed said it would be less attractive if there were fewer birds or fewer protected habitats (Table 5).

Data from the two questions (Tables 4 and 5) indicated that overwhelmingly people do not want to see the beach change, and do not want to see more people or development. Some of the suggestions, however, involve providing amenities that would not change the character of the beach (e.g., benches, trash cans, removing graffiti, signs for where to park legally).

Conservation

The above two tables describe how the beach could be more or less attractive for the people visiting this beach. In the following opening-ended question, the emphasis was on measures that can be implemented for the birds, crabs and beaches overall in terms of conservation (Table 6). In other words, what conservation measures would they like to see implemented or continued. Overwhelmingly, people wanted to see the continued protection of red knots and shorebirds, as well as ecosystem protection. Because this question also provides some information on the knowledge base of interviewees that will be useful to planners and managers, more detailed information is provided. In addition to the comments in Table 6, some people said, "Put up boards so crabs don't get caught," "Involve more young people," "Let me turn over crabs," and "Protect the baby turtles, the oyster beds, and the fish."

Table 6

Interviewee suggestions for conservation on Delaware Bay beaches. Interviewees were asked the question – What conservation measures would you like to see implemented? Interviewees could not answer (31 did not), say they like it as it is, or provide suggestions. Because this information will be useful in providing guidance to create information and outreach materials, more detail is given than might be necessary. Only 224 people provided suggestions (percent based on 224)

Answers	Number	Percent
I don't know or did not answer	31	
Less restrictions	2	
Keep as is	22	
Outreach (49 of 224 = 22%)		
More stewards	27	12
Stewards who know more	6	3
More education and signage	16	7
Ecosystem protection and restoration (48 of 224 = 21%)		
Legislative and enforcement	24	11
Clean water and beaches	9	4
Provide platforms (keep people in few places)	7	3
No more development along bay shore	5	2
Protect marsh, dunes, restore sand on the beach	3	1
Red knots and shorebirds (144 of 224 = 59%)		
Protect shore beaches (more protection)	72	32
Create more "restricted" or longer protected beaches	44	20
Protect birds more	16	7
Enforce more shorebird beach protection	10	5
Keep peregrines out (4) and don't shoot shorebirds (3)	7	3
Horseshoe crabs (83 of 224 = 37%)		
Protect crabs from bait fishing	34	15
More flipping over of crabs	20	9
Don't harvest for medical uses (use synthetic lysate)	15	7
No harvesting (use synthetic bait)	10	5
Protect more crabs	4	2

The interviewees' comments are revealing for a number of reasons: 1) only 2 people said do less, 2) some people simply said they supported current measures, or that birds or crabs should be protected without giving any specific measures, 3) most people listed particular things they supported, and 4) 49 people mentioned outreach activities (more stewards, signage, education). Interviewees often mentioned more than one conservation measure (excluding the 20% people who did not answer or mainly said keep it "as is"). The comments below each main category (i.e. horseshoe crabs) were specific comments mentioned. Thus it gives a relative idea of the overall concerns. Of these, 22% that mentioned education/outreach, 21% mentioned ecosystem protections, 59% mentioned conservation actions with shorebirds, and 37% mentioned conservation actions with crabs. It should be noted that despite 42% of people saying they came primarily for reasons other than shorebirds or crabs, 69% of people provided comments about how to protect shorebirds, crabs, and the ecosystem.

After all the open-ended questions were answered, people were asked to rate the importance of stewards, protection, and research. The mean rating for protection of shorebirds, protection of crabs, research on shorebirds, and research on crabs were very high (top line of Table 7). Further, many of these aspects were highly correlated, except for fishing. The table shows that interviewees who rated protection and research high, also rated all the related entries high (e.g significant positive correlations in Table 7). However, this was not true for fishing: there were no significant correlations of the rating of fishing with the other protections and research (Table 7).

Table 7

Means (\pm standard error) and correlations among perceptions about the value of resources. The mean rating are given above the solid horizontal line. Correlation coefficient are given above the diagonal blank boxes, probabilities are below the line. All correlations were significant at the 0.0001 level unless otherwise listed in the table. NS = not significant.

	Stewards present	Stewards to provide information	Protection of shorebirds	Protection of crabs ^a	Protection of Fishing	Research on birds ^a	Research on crabs
Mean rating	3.9 + 1.3	3.8 + 1.4	4.7 + 0.6	4.2 + 1.2	2.2 + 1.6	4.6 + 1.2	4.1 + 1.4
Stewards present		0.65	0.28	0.33	0.004	0.32	0.30
Stewards to provide information			-0.28	0.37	0.05	0.31	0.31
Protection of shorebirds				0.40	-0.01	0.47	0.33
Protection of crabs					0.22	0.29	0.61
Protection of Fishing	NS	NS	NS	0.0009		-0.66	0.12
Research on birds			NS				0.57
Research on crabs			0.08				
a = Crabs equals horseshoe crabs and birds equal migratory shorebirds.							

There were no significant age differences in whether interviewees thought that there should be protection of shorebirds ($X^2 = 6.3, P > 0.09$) or crabs ($X^2 = 1.2, P > 0.7$), but support for shorebird research increased with age ($X^2 = 10.2, P > 0.02$, Table 8). The mean rating for research on migrant shorebirds increased from 4.24 for people under 30 years, to 4.29 (31-45 yrs), to 4.59 (46-60 years) to 4.74 for people 61 years or older. No significant difference as a function of age occurred for research on crabs ($X^2 = 2.7, P > 0.4$).

Table 8

Rating for the importance of different aspects, and ratings as a function of age^a of interviewees. These were rated on a scale of 1-5 (where 5 is the most positive). There are also significant differences as a function of age for each question (χ^2 values on the right of the table). NS = not significant.

Question	Overall Mean ^b	Less than 30	30-45	46-60	Over 60	χ^2 (P)
Protection of shorebirds	4.79 ± 0.04	4.65 ± 0.24	4.66 ± 0.11	4.75 ± 0.07	4.90 ± 0.03	6.3 (0.09)
Protection of horseshoe crabs	4.15 ± 0.08	3.76 ± 0.37	4.13 ± 0.16	4.17 ± 0.14	4.22 ± 0.12	1.2 (NS)
Research on migrant shorebirds	4.55 ± 0.05	4.24 ± 0.33	4.29 ± 0.14	4.59 ± 0.09	4.74 ± 0.05	10.2 (0.02)
Research on crabs	4.11 ± 0.08	4.0 ± 0.31	3.98 ± 0.16	4.08 ± 0.13	4.23 ± 0.12	2.7 (NS)
a. $\chi^2 = 24.5$, $P < 0.01$.						
b. $\chi^2 = 130.2$, $P > 0.0001$.						

Discussion

The main findings of this study of interviewees visiting several Delaware Bay beaches during the shorebird spring migration stopover period are; 1) people were overwhelmingly supportive of protection of and research on shorebirds and crabs. 2) visitor type, gender, and age influenced the perceptions of people 3) perceptions of the importance of resources increased with age of interviewees, and 4) women generally rated the importance of protection and research higher than did men (except for fishing). These will be discussed below.

Influence of visitor type, gender, and age on perceptions: educational needs and approaches

Visitor type was an important aspect of investigation because the data from the interviews did not support the initial hypothesis that people mainly came to these shorebird beaches to watch the shorebirds, or even the shorebirds and crabs. Nearly 40% came for other reasons. Regardless of the way the question was asked (open-ended, or choice), about the same percentage of people fell into each visitor type. Having questions addressing the same issue on different parts of the survey, and in different formats assures the reliability of the answers. The fact that so many people came to the shorebird foraging beaches for other reasons indicated that there is room for management of these beaches to enhance these other qualities. Beach stewards, for example, are largely trained to address information about the shorebirds and horseshoe crabs, but could be provided with information relevant to the other reasons people come to the beaches. Managers are increasingly aware that understanding the interests of users, and involving them in the planning process is key to obtaining support, and in some cases, contributing to conservation of the resources (Foster et al. 2013).

Further, although perhaps less “green” than other spaces, beaches are open, wild places that fulfill the same need to have an experience in nature (Labib et al. 2020).

Perceptions of research and protection of resources were influenced by visitor type, gender, and age. In general: 1) interviewees who came to see shorebirds, crabs, or both were older than people who came for fishing, other recreation, or tranquility or scenery, 2) interviewees who came strictly for the shorebirds were less likely to be first-time visitors, and more likely to visit other Delaware Bay beaches than others, 3) older interviewees rated research and protection of shorebirds and crabs higher than younger interviewees, and 4) women rated research and protections higher than men, and they rated the importance of some resources higher than men. These bear repeating because these factors (age, gender, visitor type) influenced nearly all of the information and ratings of the study. There were no differences among visitors, however, in whether they thought shorebirds and crabs should receive special attention. These data provide information that both characterizes the people coming to the Delaware Bay beaches during the shorebird stopover period, but also can be used in management and educational programs.

Gender and age differences in perceptions are not unusual (Hitchcock 2001; Lieske et al. 2014), and the focus of this paper is on these factors only as they relate to future planning and management. The average group size in the study was 2, and included both same sex and opposite-sex “couples.” The gender differences were not likely to be due to biases in the selection of interviewees, since males and females were interviewed in about equal numbers, and in many cases the interviewees were accompanied by their spouse or companion. Couples were approached and the initial request for an interview was addressed to them together, and one person usually said yes and answered all the questions. When the second member of a group wanted to answer, we declined to interview them, but did discuss the project with them after the interview. Only one person within any couple was interviewed, and their answer was recorded, even if their companion disagreed with their answer.

The differences as a function of age and gender, however, can be useful in developing educational plans and management objectives. For example, information programs (brochures, posters, internet information and approaches) can be directed specifically at different age and gender groups. The higher rating of the importance of protection and research given by older interviewees suggests a need to reach younger people, and may also portend a lack of future support for research and protection of shorebirds, crabs and the beach. It suggests that managers and conservationists should be particularly attentive to the needs of younger beach visitors, and to members of the public in general. It may also suggest that older visitors to these beaches, who have been coming longer should be encouraged to work with younger members of their communities and assume the role of “elders” imparting information to the younger generations (Flood et al. 2007; Bohnee et al. 2011; Boyd and Furgal 2019; Burger et al. in press). Information and tools provided to these “elders” could then enhance their effectiveness.

Finally, we mention in passing that over 80% of the interviewees were white, and that this in itself provides an environmental justice issue – Why aren't the Delaware Bay beaches being used by other ethnic groups? Clearly the use of these beaches needs to be broadened (Hitchcock 2001). Environmental justice does not just apply to the undue exposure of low-income or minority communities to chemicals (although this is clearly important, Brulle and Pellow 2006; Gochfeld and Burger 2011), but to the unequal access to positive benefits,

such as green and wild environments (Kondo et al. 2018; Labib et al. 2020). Part of environmental management and conservation of the shorebird beaches on Delaware Bay should include involvement of the broad range of stakeholders in the region (Burger et al. 2008; EPA 2007, 2009).

Protection and research on shorebirds and crabs

Regardless of the type of visitor, overall protection for research on shorebirds were rated very high, although research and protection of crabs was rated slightly lower (Table 7). This is a key finding because it suggests that interviewees were supportive of current management and conservation, and wanted to see these continue and be improved. Further, when asked if they thought birds and crabs should receive special protection, over 80% of all visitors (except fisherman), regardless of reason for coming to the beach, thought that birds and crabs should receive special protection (Table 2). That perceptions of the importance of research and protection was consistently confirmed in several different questions attests to its validity, and usefulness in discussions with governmental and non-governmental agencies. There is widespread support for continued protection –for shorebirds generally, not just the federally threatened red knot. While red knot is clearly in danger, some other shorebirds are also facing drastic declines, especially species that also use Delaware Bay (Brown et al. 2017). Preservation of the foraging beaches and other intertidal habitats is an important key aspect of the conservation strategy for Delaware Bay shorebirds, as it is elsewhere.

Despite the adoption of the Convention on Wetlands of International Importance, there is still a lack of protection in many wetlands and intertidal habitats (Foster et al. 2013). These zones are the transition zone between marine and terrestrial systems, and are becoming increasingly important in being the first line of defense against severe storms and sea level rise (IPCC 2014). Perhaps understanding stakeholder views, and those of users of specific beaches can be used to foster sustainability both of beach tourism (e.g. Chen and Teng 2016), but also of the resources themselves (Foster et al. 2014).

Implications for conservation and management

The overall goal of the Delaware Bay Shorebird Project is to protect and enhance the populations of red knots and other shorebirds migrating through Delaware Bay within the context of a healthy, complex ecosystem (Niles et al. 2008, 2009). Migratory shorebirds, however, depend upon a substantial population of spawning horseshoe crabs (ASMFC 1998, 2009). Other species on the food chain of Delaware Bay also depend on the eggs and larvae of horseshoe crabs, including many invertebrates, scavengers, small fish, and predatory fish and birds. The shorebirds and crabs clearly need extensive management to preserve the system (Niles et al. 2008, 2009; USFWS 2014a, 2014b), and part of the management has to include visitors who come to the bay to observe the bird, as well as the local communities.

The data show that there are differences in perceptions as a function of visitor type, age and gender, and this information can be used in an education program that includes internet communications that appeal to younger visitors to the bay, especially those with children. The ratings for both research and conservation of shorebirds and crabs were quite high, even though there were age and gender differences. This suggests strong support for these programs (Table 9). Structurally, education and community involvement in management and development of rules and regulations are critical to the success of the Delaware Bay Shorebird Project. The interviewees, regardless of the reasons they came to the bay, support conservation and

research with both shorebirds and crabs, and this could be a basis for more involvement in management and conservation.

Table 9

Management and planning recommendations to improve the already successful conservation program for shorebirds on Delaware Bay. The recommendations follow from the data on perceptions of those interviewed, and those of the interviewers.

Recommendation	Implementation suggestions
Continue current management	Since there is strong support for current management, these measures should be continued (logistics and funding)
Provide beach stewards, normally trained to address information about the shorebirds and horseshoe crabs, with information relevant to the other reasons people come to the beaches.	Use information from a full range of stakeholders using the Delaware Bay beaches to develop information and approaches that apply to all the groups (not just those interested in red knots, shorebirds, or crabs)
Develop information programs directed specifically at different age and gender groups.	Develop age- and gender specific brochures, posters, internet information and approaches, with the different age and gender groups
Involvement a broad range of stakeholders from the region in information, education and management of shorebirds (and crabs).	While the interviewees represented a range of age, gender and visitor types, there was little ethnic diversity, and efforts should be made to improve access by minority and low-income local residents.
Involve local community leaders, representatives and state personnel directly in management	Perceptions of local leaders can be solicited, along with involvement directly in management and conservation.
Understanding of stakeholder views should be used to foster sustainability.	The perceptions of the visitor types, advantages and disadvantages, and conservation suggestions can be used to improve the beach experience for both shorebirds and beach-goers, as well as the total Delaware Bay ecosystem.
Convene a Delaware Bay group to improve the shorebird-crab relationship, the whole Bay ecosystem, as well as the visitor (and resident) experiences	Develop a committee of conservationists, birders, fishermen, recreationists regulators, government officials and local residents to work toward ecosystem improvement that includes a diversity of stakeholders and addresses environmental justice.

Both the increase in beach tourism, and the strong support of beach tourists as indicated by the interviewees in this study, suggest that there is a need for practical, acceptable, strong, sustainable policies. Clearly increases in the number of people to these beaches would detract from the interviewees' enjoyment of the beach, and these views need to be taken into account (see Chen and Teng). In other places, the importance of the perceptions of visitors to beaches have played a key role in developing management strategies (Antos et al. 2006; Ballantyne et al. 2009; Chen and Teng 2016; Harris et al. 2020), although often these deal with protective structures on beaches (e.g. dunes, replenishment, hard engineered structures, Charbonneau et al. 2019).

While Table 9 summarizes our recommendations that flow directly from the data, we suggest another that could use these data and others to improve the already very successful Delaware Bay Shorebird Project, including expanding it to include the complex food chain that begins with horseshoe crabs. The Project has been successful in providing additional high quality habitat, and admirably managed the stewardship program with the result of supporting the majority of the red knots using Delaware Bay as a stopover (Dey et al. 2020). However, it is essential to increase population of spawning horseshoe crabs and the number of knots, and improve the overall ecosystem. We suggest that a group of people intimately concerned about the health of both the ecosystem (including shorebirds) and the experiences of beach-goers be convened to discuss ways to improve both conservation of the Delaware Bay ecosystem and the conservation of the visitors' experiences. Such a group might include conservationists, birders, other recreationists, regulators, government officials, and local residents. Such a group might use the current data and their own experiences to aid in the management of the Delaware Bay beaches, and the Delaware Bay Shorebird Project.

Statements And Declarations

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Author contribution: The senior author designed the study and participated in conducting the interviews. The senior author and Kelly Ng designed and conducted the data analysis. Burger wrote the first draft, and all authors contributed to editing the ms.

Author Consent: All authors have edited and read the ms and consent to its publication.

Ethics approval: No individual identifiers or economic information was obtained from the interviewees. Appropriate introductory material was provided about the study objectives, the university involvement, that it was voluntary and no personal identifiers were being asked, and how they could obtain information if they so desired. The protocol was approved by the Rutgers University Institutional Review Board (Protocol E16-123).

Availability of data and material: The original data are available upon request from the senior author (Rutgers University).

References

1. Andres BA, Smith PA Morrison RG, Gratto-Trevor CL, Brown SC, Population estimates of North American shorebirds (2012) Wader Study Group Bull 119:178–194
2. Antos MJ, Weston MA, Priest B (2006) Factors influencing awareness of community-based shorebird conservation projects in Australia. Appl Environ Educ Commun 5:63-72
3. Atlantic States Marine Fisheries Commission (ASMFC)(1998). Interstate Fishery Management Plan for Horseshoe Crab. ASMFC, Washington, D.C
4. Atlantic States Marine Fisheries Commission (2009). A Framework for Adaptive Management of Horseshoe Crab Harvest in the Delaware Bay Constrained by Red Knot Conservation. November 2009, 46 pgs
5. Baker AJ, Gonzalez PM, Piersma T, Niles LJ, deLima I, Nascimento S, Atkinson PW, Collins P, Clark N, Minton CDT, Peck MK, Page S (2004) Rapid population decline in red knots: fitness consequences of refuelling rates and late arrival in Delaware Bay. Proceed Royal Soc London 271:875-882
6. Baker A, Gonzalez P, Morrison RIG, Harrington BA (2013) Red Knot (*Calidris canutus*) In The Birds of North America Online Cornell Lab of Ornithology, ed. A. Poole. Ithaca, NY: America Online. <http://bna.birds.cornell.edu.bnaproxy.birds.cornell.edu/bna/species/563>. Accessed January 3, 2020
7. Ballantyne R, Packer J, Hughes K (2009) Tourists' support for conservation messages and sustainable management practice in wildlife tourism experiences. Tour Manage 30:658-664
8. Bohnee G, Mathews JP, Pinkham J, Stanfill J (2011) Nez Perce involvement with solving environmental problems: history, perspectives, Treaty rights, and obligations. In Burger J (ed). Stakeholders and Scientists: achieving implementable solutions to energy and environmental issues. Springer: New York, NY. Pp 149-184
9. Boyd AD, Furgal CM (2019) Communicating environmental health risks with Indigenous populations: A systematic literature review of current research and recommendations for future studies. Health Commun 34:1564-1574
10. Brown S, Hickey C, Harrington B, Gill R (Ed)(2001) The U.S. shorebird conservation Plan. 2nd edition. Manomet Center for Conservation Sciences. Manomet, MA, USA.
11. Brown SC, Tratto-Trevor R, Porter EL, Weiser D, Mizrahi R, Bentzen M, Boldernow R, Clay S, Freeman M, Ciroux C, Kwon E, Lank DB, et al. (2017) Migratory connectivity of Semipalmated Sandpipers and implications for conservation. Condor 119:207-224
12. Brulle RJ, Pellow DN (2006) Environmental justice: human health and environmental inequities. Annu Rev Public Health 27:103-124
13. Burger J (1986) The effect of human activity on shorebirds in two coastal bays in Northeastern United States. Environ Conserv 13:123-130
14. Burger J, Dey A (in revision). Importance of protection efforts for conservation of Red Knots (*Calidris canutus rufa*) and other shorebirds on Delaware Bay, New Jersey, Wader Study Bull (in revision)
15. Burger J, Gochfeld M (2016) Habitat, population dynamics and metal levels in colonial waterbirds: A food chain approach. CRC Press, NY, NY
16. Burger J, Niles L (2013a) Shorebirds and stakeholders: Effects of beach closure and human activities on shorebirds at a New Jersey coastal beach. Urban Ecosys 16:657-67.

17. Burger J, Niles L (2013b) Closure versus voluntary avoidance as a method of protecting migratory shorebirds on beaches in New Jersey. Wader Study Group Bull 120:20-25
18. Burger J, Niles L (2014) Effects on five species of shorebirds of experimental closure of a beach in New Jersey: implications for severe storms and sea-level rise. J Toxicol Environ Health 77:11102-11113
19. Burger J, Niles L (2017) Shorebirds, stakeholders, and competing claims to the beach and intertidal habitat in Delaware Bay, New Jersey, USA. Nat Sci 9:181-205
20. Burger J, Tsipoura N (2019) Resident status influences perceptions about beach resources, valuation, and restoration. Urban Ecosys 22:785-793
21. Burger J, Gochfeld M, Pletnikoff K, Snigaroff R, Snigaroff D, Stamm T (2008) Ecocultural attributes: evaluating, ecological degradation in terms of ecological goods and services versus subsistence and tribal values. Risk Anal 28:1261-1271
22. Chen COL, Teng N (2016) Management priorities and carrying capacity at a high-use beach from tourists' perspectives: A way towards sustainable beach tourism. Marine Pol 74:213-219
23. Colwell MA (2010) Shorebird ecology, conservation and management. University of California Press, Los Angeles
24. Dey AD, Niles LJ, Smith JAM, Siyters HP, Morrison G (2020) Update to the status for the Red Knot (*Calidris canutus rufa*) in the Western Hemisphere. NJ Department of Environmental Protection, 17 pgs. Trenton, NJ
25. Duijins S, Niles LJ, Dey A, Aubry Y, Friis C, Koch S, Anderson A, Smith PA (2017) Body condition explains migratory performance of a long-distance migrant. Proc R Soc B 284:20171374
26. Environmental Protection Agency (EPA) (2007) Northeast National Estuary Program Coastal Condition. Partnership for the Delaware Estuary. Environmental Protection Agency, Washington DC.
27. Environmental Protection Agency (EPA) (2009) Environmental justice: compliance and environment. Environmental Protection Agency Washington DC
28. Flood J P, McAvoy LH (2007) Voices of my ancestors, their bones talk to me: How to balance US Forest Service rules and regulations with traditional values and culture of American Indians. Res Human Ecol 14:76-89
29. Foster NM, Hudson MD, Bray S, Nicholls RJ (2013) Intertidal mudflat and saltmarsh conservation and sustainable use in the UK: a review. J Environ Manage 126:96-104
30. Galbraith H, Jones R, Park R, Clough J, Herod-Julius S, Harrington B, Page G (2002) Global climate change and sea level rise: potential losses of intertidal habitat for shorebirds. Waterbirds 25:173-183
31. Galbraith H, DesRochers DW, Brown S, Reed JM.(2014) Predicting vulnerabilities of North American shorebirds to climate change. PloSOne 9:e108899
32. Gochfeld M, Burger J (2011) Disproportionate exposures in environmental justice and other populations: outliers matter. Am J Publ Health 1:S53-63
33. Goss-Custard JD, Triplet P, Sueur M, West AD (2006) Critical thresholds of disturbance by people and raptors in foraging wading birds. Biol Conser 127:88-97
34. Hitchcock JL (2001) Gender differences in risk perception: broadening the contexts. Risk: Health, Safety Environ 179:179-204

35. Intergovernmental Panel on Climate Change (IPCC) (2014) Climate change 2014: impacts, adaptation, and vulnerability. Geneva: Intergovernmental Panel on Climate Change.
<http://www.ipcc/ch/report/ar5/wg2>.
36. Koch SL, Paton PWC (2014) Assessing anthropogenic disturbances to develop buffer zones for shorebirds using a stopover site. *J Wildl Manage* 78:58-67
37. Kondo MC, Fluehr JM, McKeon T, Branas CC (2018) Urban green space and its impact on human health. *Int J Environ Res Publ Health* 15:445- 473
38. Labib SM, Lindley S, Huck JJ (2020) Spatial dimensions of the influence of urban blue-green spaces on human health: a systematic review. *Environ Res* 180:10889
39. Lieske DJ, Wade T, Roness LA (2014) Climate change awareness and strategies for communicating the risk of coastal flooding: a Canadian maritime case example. *Estuar Coastal Shelf Sci* 140:83-94
40. Martin B, Delgado S, de la Cruz A, Tirado S, Ferrer M (2015) Effects of human presence on the long-term trends of migrant and resident shorebirds: evidence of local population declines. *Anim Conserv* 18:73-18
41. McGowan CP, Hines JE, Nichols JD, Lyons JE, Smith DR, Kalasz KK, Niles LJ, Dey A, Clark NJ, Atkinson JPW, Minton CDT, Kendall W (2011) Demographic consequences of migratory stopover: linking red knot survival to horseshoe crab spawning abundance. *Ecosphere* 2:1-21
42. Morrison RIG, Aubrey Y, Butler RW, Beyersbergen GW, Donaldson GM, Gratto-Trevor CL, Hicklin PW, Johnson VH, Ross RK (2001) Declines in North American shorebird populations. *Wader Study Group Bull* 94:37-42
43. Morrison RIG, Davidson NC, Wilson JR (2007) Survival of the fittest: body stores on migration and survival in Red Knots, *Calidris canutus islandica*. *J Field Ornith* 38:479– 487
44. Niles LJ, Sitters HP, Dey AD, Atkinson PW, Baker AJ, Bennett KA, Carmona R, Clark KE, Clark NE, Espoz CM, Gonzalez PM, Harrington BA, Hernandez DE, Kalasz KS, Lathrop RG, Matus RM, Minton CDT, Morrison RIG, Peck MK, Pitts W, Robinson RA, Serrano IL (2008). Status of the Red Knot, *Calidris canutus rufa*, in the Western Hemisphere. *Studies Avian Biol* 36:1-185
45. Niles LJ, Bart J, Sitters HP, Dey AD, Clark EE, Atkinson PW, Gillings S, Gates AS, Gonzalez PM, Hernandez DE, Minton CDT, Morrison RIG, Porter RR, Ross RD, Veitch R (2009) Effects of horseshoe crab harvest in Delaware Bay on Red Knots: are harvest restrictions working? *BioSci* 59:153-164
46. Statistical Analysis Systems (SAS) (2020) Cary, NC.
47. U.S. Fish and Wildlife Service (USFWS) (2014a) Threatened species status for the *Rufa* red knot. 79 Federal Reg. 238 (2014 December 11):73706-73748
48. U.S. Fish and Wildlife Service (USFWS) (2014b) *Rufa* red knot background information and threat assessment. Supplement to Endangered and Threatened Wildlife and Plants; Final Threatened Status for the *Rufa* red knot (*Calidris canutus rufa*). [Docket No. FWS-R5-ES-2013-0097; RIN AY17] U. S. Fish and Wildlife Service, Pleasantville, New Jersey, USA.

Figures



Figure 1

Delaware Bay map showing the locations of the beaches where interviews were conducted.

Figure 2

The primary reason that interviewees said they came (bottom of figure) to Delaware Bay beaches, and the total percent of people that gave each reason as one of their top three reasons for coming to the Delaware Bay beaches. The primary reason (here after called visitor type) add up to 100 %. Given are percent from a choice question.

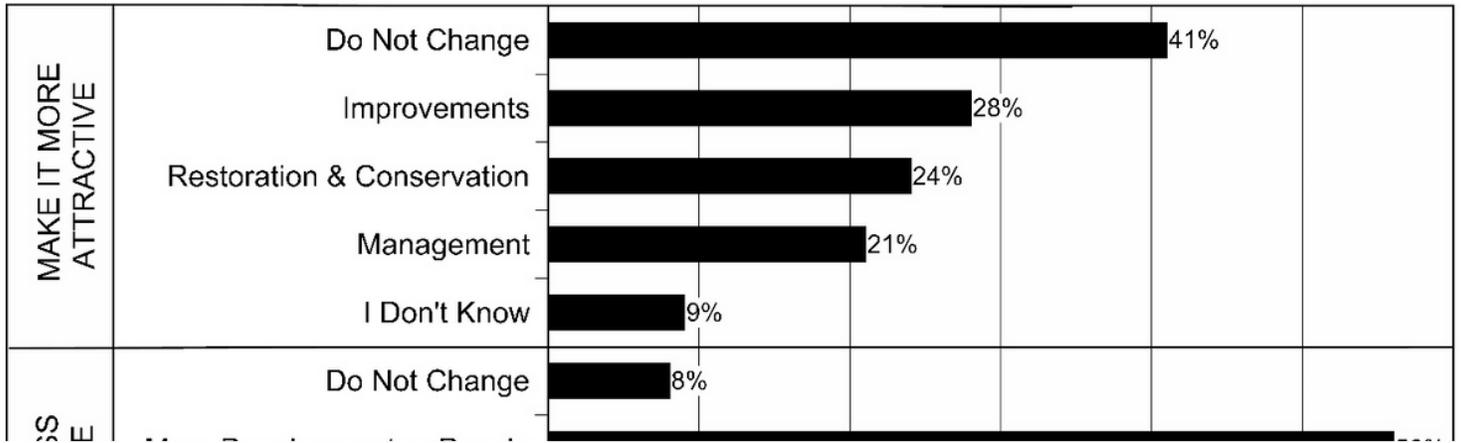


Figure 3

Perceptions of what would make the beach more or less attractive for interviewees. The percent within each type (more attractive, less attractive) add up to more than 100 percent because some interviewees mentioned issues in more than one category.