

Perceptions of Beach Stewards and Information Needs for Shorebird Stopover Sites Vary as a Function of Visitor Interests: Improving Stewardship Programs in Coastal Landscapes

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ABSTRACT

Many studies have demonstrated that some of the activities of people can disturb nesting and foraging birds, particularly along coasts and estuaries. Some managers respond to human disturbance of sensitive species by closing beaches, but most have stewards monitor and restrict access to beaches or portions of beaches. Yet little is known about the type of visitor or their perceptions of beach stewards. This paper explores the general acceptance of beach stewards and their role in conservation of red knots (*Calidris canutus rufa*), other shorebirds, and horseshoe crabs (*Limulus polyphemus*) along the Delaware Bay (New Jersey) beaches by interviewing 279 visitors during the stopover period. While most people came to see the shorebird and horseshoe crab spectacle (60%), many came for the scenery, tranquility, and recreation. Just over half of the people interviewed said that the stewards were helpful (58%), although most of those that answered this question later said that they provided conservation value (86%), but only 40% said they relied on the stewards for information. On a Likert rating scale of 1 to 5 (the highest value), the mean rating for whether it was important for stewards to be present was 3.87 ± 0.09 , and the rating for the presence of stewards who can provide information was 3.71 ± 0.11 . In contrast, protection of shorebirds was rated a mean of 4.79 ± 0.04 . There were significant visitor type differences in how important stewards were, but not in the importance of stewards who can provide information. Fishermen, recreationists, and people coming for scenery and tranquility rated the

presence of stewards higher than those visitors who were interested in either shorebirds or crabs (or both). Ratings also differed significantly as a function of age and gender; older adults and females rated characteristics higher than did people under 30 years and males. Information needs identified by stewards are also discussed. These data can be used by the managers developing a strategy for conservation of shorebirds and other species sensitive to disturbance, and for the implementation of an effective stewardship program.

1. INTRODUCTION

Animals have very specific habitat requirements, which provide them with space, food and other environmental needs. These requirements may vary as a function of age, stage in the reproductive cycle, predators and competitors, geographic locations, weather, and other physical factors. Many birds have a life cycle that includes habitats that are hundreds of miles between breeding and wintering grounds. For example, some species of shorebirds fly from northern breeding grounds in the Arctic to wintering grounds in the southern Hemisphere. Shorebirds undertake these long migrations to obtain sufficient food and environmental conditions to allow survival and reproduction [1-5]. These long-distance shorebird migrations usually include a small number of stopover sites where shorebirds replenish fat, allowing for further migration and for the species to arrive on the breeding grounds with sufficient energy stores to quickly breed [6, 7]. With global change, including increases in human populations, increasing temperatures, and sea level rise, shorebirds and other coastal-nesting species are at risk [8-12].

Increasing human populations, combined with the movement of more people concentrating along coasts, results in decreasing suitable habitat for migrating shorebirds, as well as increasing human disturbance [10, 13]. For example, habitat loss can be due to land development, marina development, loss of mudflats due to sea level rise, or loss of intertidal habitat to recreation, aquaculture, or other purposes [8, 9, 14, 15]. While habitat loss directly impacts the availability of food for migrant shorebirds, some human activities can disturb shorebirds, depriving them of sufficient time to forage and lay down the fat necessary for successful migration. The loss of sufficient habitat for foraging, loss of prey base, and human disturbance can result in impacts on survival, and subsequent population declines as happened in the red knot (*Calidris canutus rufa*) [6, 16, 17]. Red knots are federally threatened, and their population declines have been attributed to a decline in available eggs of horseshoe crabs (*Limulus polyphemus*) [7, 18]. The declines in the availability of crab eggs make it even more important to protect the remaining foraging habitat for red knots and other shorebirds.

One of the methods to reduce disturbance to migratory shorebirds is to close off particularly important foraging areas to human presence during critical stopover periods. Protected areas are usually protected by signs, ropes, law-enforcement patrols, and/or stewards that are tasked with keeping people away from critical foraging areas, educating the public, and providing specific information to visitors. Stewards have been an important component of the protection of shorebirds migrating through Delaware Bay since the early 2000's [3]. Yet, the effectiveness of stewards, and the perceptions of the public about stewards are seldom examined (but see [19, 20]).

In this paper, we examine the views and perceptions of visitors to 9 beaches on the New Jersey side of Delaware Bay (New Jersey, USA). Our objectives were to determine: 1) why people visited the beach, 2) whether they talked to beach stewards, 3) whether they thought stewards were important, and why, 4) whether they thought having stewards with information was important, and 5) what kinds of information they would like. We also were interested in their rating of the importance of protecting shorebirds and crabs, and their rating of the importance of conservation of shorebirds and crabs. Enhancing the stewardship program is an integral part of the conservation strategy for shorebirds migrating through Delaware Bay and understanding visitor perceptions is an important component. We propose that obtaining information on the types of visitors to key shorebird foraging beaches, and on their perceptions and attitudes of stewards, can lead to a more effective stewardship program. The direct inclusion of the views and percep-

tions of a range of stakeholders is one of the most effective methods of achieving management goals of conserving sensitive species [18, 19, 21].

2. BACKGROUND

Delaware Bay is one of the largest and most important migratory stopover sites for shorebirds (including the federally threatened red knot) in North America [6, 16]. Protecting shorebirds during their migratory stopover is a key conservation goal of both the New Jersey State and U.S. federal governments as Delaware Bay has been identified as a key critical stopover site in North America [18, 21]. Red knots (*rufa* subspecies) breed in the sub-Arctic and Arctic, migrate south in the fall along the Atlantic coast, stopping at a few places to refuel. Most winter along the U.S. Atlantic coast, on Caribbean islands, and along northern South America, but some migrate to Tierra de Fuego (30,000 km trip) [6, 7, 22, 23]. When they arrive in Delaware Bay in May on their northward migration, they are fat-depleted, and have about 2 weeks to nearly double their weight to be able to fly to their breeding grounds and initiate breeding [5-7].

Red knots and other shorebirds forage on beaches, mudflats, and marshes along the Atlantic Coast and on Delaware Bay [24, 25]. Their primary prey is horseshoe crab eggs [26], which have declined significantly due to overharvesting of horseshoe crabs [7, 27, 28]. A decline in horseshoe crab eggs has likely had an effect on the declines of other shorebird species using Delaware Bay as a stopover [29]. While considerable attention has been devoted to managing horseshoe crab harvest and protection of shorebirds [18, 21], red knot populations have not increased [3, 21]. The harvesting of horseshoe crabs for bait is managed by the Atlantic States Marine Fisheries Commission; their Management Plan requires taking into account the foraging needs of red knots and other shorebirds [27]. The U.S. Fish & Wildlife service is responsible for developing a recovery plan for red knots [30].

Shorebirds, including red knots, often fly away in response to people, and if time or resources are limited, then such disturbances may have a severe effect on survival or subsequent reproduction [14, 31-33]. One of the key components of conservation of shorebirds is to close off areas, have fences or signage, and have beach stewards that encourage or enforce closures [34]. In earlier studies with shorebirds on beaches, we found that signage alone is often not effective in persuading some people to avoid disturbing foraging shorebirds. Local police patrolling a beach where migrating shorebirds foraged was a very effective measure [32, 34, 35]. On Delaware Bay, several conservation measures have been instituted by the state to protect critical foraging areas, including restricting people from key foraging beaches from early May to early June, the period of the main migration of shorebirds through the Bay [3, 13]. Beach closures with the presence of stewards can also be effective. It may be particularly effective because Le Corre *et al.* [18] showed that most people they interviewed at a wintering site in California believed that their own presence had no adverse effect on bird populations. Site-specific information on the perceptions of beachgoers can thus aid in improving education and a stewardship program.

3. METHODS

3.1. Study Site

The study was conducted at 9 beaches along the New Jersey side of Delaware Bay from Villas Beach north to Fortescue Beach (Figure 1). The habitat was generally shallow sandy beaches, with extensive mudflats and sandy shoals at low tide. Some beaches were bordered by salt marshes, while other beaches were bordered by roads or houses. Many of the beaches were accessible by driving to the end of a suburban street, while others were accessible by driving on dirt roads through salt marshes. Stewards were assigned to all 9 beaches from morning (about 0900 to 1700, depending upon the beach), and personnel. Visitors, however, were interviewed from 0600 to 1900, depending on their presence and weather (see below).

3.2. Protocol

From 10 May 2021 until 10 June 2021, we interviewed 279 people who visited 9 beaches on the New



Figure 1. Delaware Bay Map showing the locations of the beaches where interviews were conducted.

Jersey side of Delaware Bay. Interviews were conducted by trained personnel, and pilot interviews were completed prior to implementation of the study. Two people were dedicated to interviews during the study period, and normally conducted interviews from 6 am to dusk each day. To avoid bias in the selection of people to interview, the interviewers asked the first person to approach the beach if they could be interviewed; upon completion of that interview, the next new person to arrive at the beach was interviewed. Since many of the access points are at the end of a road, it was easy to determine who had just arrived. To obtain interviews from all beaches, interviewers normally remained at a given beach for 3 - 4 hours, and then moved on to another, pre-determined the night before to achieve both coverage of the different beaches, while optimizing the number of people interviewed. Interviewers introduced themselves and explained they were conducting a study for American Littoral Society and Rutgers University, as well as that no individual identifiers (e.g. name, address) were asked, and that data would be combined into categories. Refusal rate was low (less than 8%) and was largely due to time constraints or presence of children.

The interview instrument was similar to other forms used in the past, although the questions themselves differed [20]. The interview form was a page long, and contained information on demographics (age, gender, number of people in the group), home community, visitation rates, and open-ended questions on why they came, whether they felt stewards helped, how stewards helped, and what kinds of information interviewees would like from stewards. It also contained rating questions on the importance of stewards, stewards who could provide information, and about research on shorebirds and crabs. Open-ended questions were asked early during the interview to solicit free and unbiased answers, and rating questions of provided choices were placed later on the questionnaire.

The interview itself required anywhere 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 questions that were later on the interview form. People often wanted to express other thoughts about the stewardship program, or the shorebirds or crabs, or both—resulting in very long interviews.

Rating questions used a Likert Scale of 1 - 5, where 1 is the lowest value and 5 is the highest value (e.g., the highest rating). Differences among categories were determined by Chi-Square tests where appropriate, and we distinguished the differences using Duncan Test [36].

In parallel, we had the stewards ask only a limited number of questions that were similar to those on our survey. We wanted to see whether key questions could be asked by stewards, even considering the biases involved with stewards asking about stewards in general, as well as other features. We present these results only in passing as a potential method of obtaining information with personnel already on these sites. None of the people interviewed by the stewards were interviewed for our overall study. We expected that the stewards would only ask receptive people if they could interview them with a very short form.

4. RESULTS

4.1. Demographics

Of those interviewed, 47% were female, and 53% were male. Average group size was 2 ± 0.09 . Of those interviewed, 8% were under 30 years of age, 20% were 31 - 45, 31% were 46 - 60, and 41% were over 60 years. The average age was 54 ± 0.09 years. Fewer than 30 people had children with them. The people interviewed mainly self-identified as white (81%); others identified as Latin/Hispanic (7%), Black (5%), and Asian (4%); the rest self-identified as other.

4.2. Visitors and Visitation Rates

Most people had visited the Delaware Bay beaches before (77%), while it was the first time for 23% of the visitors. Most visitors 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). 55% have been coming for up to 10 years, with another 20% coming for 11 - 20 years, the time the shorebirds have received considerable media attention.

Visitor type refers to the reason why people came to this beach. The “shorebirds” category are only visitors who said they came to watch birds, shorebirds or red knots; for “horseshoe crabs” it is the group of people who said they came to see or learn about horseshoe crabs. “Shorebirds and crabs” refers to people who mentioned that they came to see both. “Recreation and other” is a broad category that included walking, photographing, letting children play, and looking for Cape May diamonds and beach glass. A few people mentioned they liked to turn over crabs when there was no one telling them not to.

While many assume that people are mainly drawn to these beaches because of the shorebirds, there are actually a number of reasons why people come during the shorebird migration season (Table 1). There are two ways to determine this, including open-ended questions (why did you come here), and a choice questions (pick the primary reason you came from a list they were given). There was remarkable congruence between the answers to these two types of questions that were located far apart on the interview. That almost the same percentage of people volunteered that they came for shorebirds and/or crabs whether it was an open-ended question, or whether it was a choice of options question demonstrates there is internal consistency in how people are answering the question. In the rest of the paper, we use the primary reasons as the designation for visitor types. What makes this beach attractive goes partly to the other aspects of the beach—is it a pleasant and tranquil scene, for example.

Visitor type varied by gender (Figure 2, $X^2 = 21.9$, $df = 6$, $P < 0.001$). In general, men came for recreation and fishing more than did women (23% vs 10%), and more women came to see crabs than did men (13% vs 2%). However, the percentages that came to see shorebirds, or both crabs and shorebirds, were similar.

When asked whether they visited other beaches, people responded as follows. 1) 67% said they go to other beaches to watch birds, 2) 40% said they go to other beaches to watch crabs, and 3) only 12% said they go to other Delaware Bay beaches to fish. Indeed, interviewers reported that they saw people they had interviewed at other beaches, sometimes on the same day, and sometimes on different days.

At the end of the survey, we asked what organizations they belonged to (and if they asked for clarification we said, for your interests). This provided an indication of environmental activity. Well over half of the people did not belong to any organizations (157 people, 56%), and another 8% (22 people) did not answer. The organizations people belonged to were largely local or regional, such as Audubon Society (National and state), Cape May Bird Observatory, Nature Conservancy, and Sierra Club.

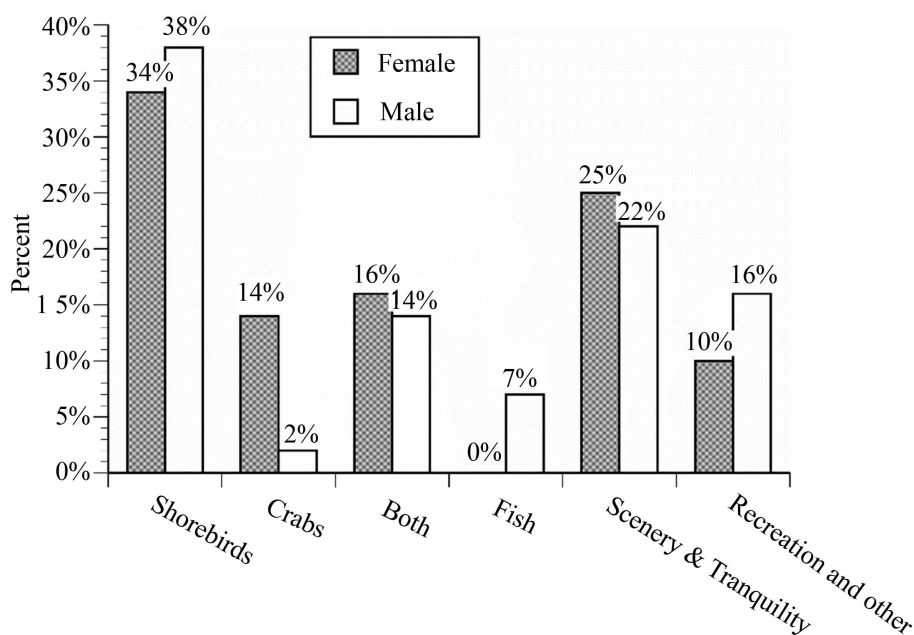


Figure 2. Gender differences in visitation as a function of visitor type.

Table 1. Reasons why people come to the Delaware Bay beaches during Spring migration of shorebirds (N = 279). Given are the percent of people answering each question as a function of visitor type.

Visitor Type	Why did you come? (open-ended)	Primary reason for coming (choice)	What makes this beach attractive? (open-ended)
Shorebirds (Knots, birds)	38	37	31
Shorebirds and crabs	15	15	7
Horseshoe Crabs	5	8	9
Fish	7	4	4
Scenery and Tranquility	11	25	33
Recreation/other	24	13	18

4.3. Perceptions about Beach Stewards

The main objective of this paper is to examine the perceptions of visitors to the Delaware Bay shorebird beaches about stewards, and interviewees were asked about their perceptions in both open-ended questions and by rating questions. Several different questions on the survey addressed whether people thought the stewards were helpful (Table 2). There were no gender or age-related differences in responses to the questions in Table 2 (X^2 tests).

These results are instructive in that most people answered the question about whether stewards helped, but not about whether they provided conservation value; 33% did not want to answer whether they provide conservation value. Similarly, 22% chose not to answer the question about relying on stewards for information. Still, of those that did answer, over half of the people thought stewards helped, and 86% thought stewards provided conservation value. These questions were open-ended, and people could say what they wanted—they answered with short answers. For comparison, 96% of 274 interviewees said shorebirds should be protected, 87% of 273 interviewees said crabs should be protected. The latter two questions were after the question about whether stewards helped—thus it was not the location of the question on the questionnaire that influenced answers.

Another method of evaluating stewards was by rating questions, where people were asked to rate stewards and other measures on a scale of 1 - 5 (although many people answered 0, these were considered a 1). The interviewees were not physically close to stewards during interviews, and the answers were confidential (Table 3). Interviewees were asked to rate a number of characteristics about Delaware Bay, including the importance of stewards (Table 3). People rated the protection of shorebirds the highest, followed by research on migrant shorebirds. The importance of stewards (and stewards who can provide information) was rated significantly lower than the questions about shorebirds and crabs (Table 3). These findings are robust because the whole data set is used (e.g., 279 participants, note the low standard error).

It is clear from Table 3 that most people, regardless of why they came, did not rate the stewards as highly as they rated protection of shorebirds and research on shorebirds. Further, as was clear from Table 3, many people did not choose to even rate them, and others said they did not know what they were or did not ever see them. The latter two responses are interesting since the questions about stewards were positioned at different places on the survey form—thus it was not a case of people getting tired and not wanting to answer the question (some just did not answer although they answered later questions).

Whether people felt that stewards helped (in their experience) also varied by the type of visitor (Table 4). People whose primary reason for coming was scenery and tranquility were significantly more likely to

Table 2. Attitudes toward stewards on Delaware Bay beaches. Some people did not want to answer (last column below). The percentages for the other answers are based only on the people who did answer.

Question	% Yes	% Maybe	% No	% Don't know	# Didn't answer
Do you think Stewards help?	58	7	13	22	24
Do Stewards provide conservation value?	86	9	5	0	92
Do you rely on Stewards for information?	40	4	56	0	61

Table 3. Rating for the importance of different aspects. These were rated on a scale of 1 - 5 (where 5 is the most positive).

Question	Mean ± standard error
How important is it for stewards to be present?	3.87 ± 0.09
Stewards who can provide information?	3.71 ± 0.11
Protection of shorebirds	4.79 ± 0.04
Protection of Horseshoe Crabs	4.15 ± 0.08
Research on migrant shorebirds	4.55 ± 0.05
Research on Crabs	4.11 ± 0.08
X ²	130.24 (<0.0001)

Table 4. Percepts of stewards and their performance as demonstrated by different questions that were asked at different times in the interview. The actual ratings (described below) are also an important indicator of visitor perceptions.

Visitor type	Percent spoken to a steward (% yes)	Do you think stewards help? (% yes)	Are stewards important (% rating 4 or 5)	Stewards who can provide information (% rating 4 or 5)
Shorebirds (Knots, birds)	28	66	38	53
Shorebirds and crabs	29	50	31	71
Horseshoe Crabs	22	46	39	84
Fish ^a	69	47	32	63
Scenery and Tranquility	64	70	25	65
Recreation/other	49	51	51	68
X ² (P)	21.1 (0.0008)	30.9 (0.009)	41.1 (0.003)	27.5 (0.09)

a: A relatively small sample size.

have spoken to a steward, and to think stewards helped (conservation), but less likely to rate the importance of stewards as high (rating of 4 or 5) as other visitor types. People interested in the shorebirds and crabs (and crabs alone) rated the importance of having stewards who can provide information similarly to others. Further, in [Table 4](#), the lack of as high a significance level in [Table 3](#) is partly due to the smaller sample size of each category. That is, the total sample size for visitors is 279 (divided among the 6 types of visitors), while in [Table 3](#), the whole sample of visitors answered each question.

Most people declined to say why they rated stewards low, if they did so. Those that did answer said things like—“they don’t respect locals”, “they are not doing their job”, “they are too bossy”, “they make me leave”, and “I didn’t see them”. Some people expressed a desire “to see them”, and be “able to ask questions”.

Another method of examining perceptions of the importance of stewards is using the ratings as a function of visitor type ([Table 5](#)). The different types of visitors rated how important stewards are, and how important stewards who can provide information are. Oddly, people who said they came to see red knots, shorebirds, or birds, and horseshoe crabs rated the importance of stewards lower than did people who came to fish, see the scenery, or see *both* shorebirds and crabs (with this type of question, a $P < 0.1$ is often considered significant). This suggests that people who come to see the birds or the crabs do not value the stewards as highly as others. There was no significant difference in how important it was to have stewards who can provide information. If stewards are present, everyone wants them to be able to provide information.

Age was another factor that influenced how people rated the presence of stewards who could provide information ([Table 6](#), $X^2 = 20.6$, $df = 12$, $P < 0.05$). The mean rating for the importance of stewards who can provide information increased significantly with age. The markedly lower rating of people under 30 may reflect their greater reliance on the internet for information.

Gender also influenced the relative ratings of some aspects examined in this survey ([Table 7](#)). Females had a significantly higher rating for the importance of stewards, and protection of birds than did males, while males rated the importance of fishing higher than did females. There were no significant gender differences in the other aspects examined. However, except for fishing, females rated all aspects higher than males. Clearly, there were no gender differences in their view of whether there should be research on migrant shorebirds and horseshoe crabs.

Table 5. Rating of how important is it that stewards be present, and that stewards be present that can provide information, by visitor type.

Visitor Type	Percent talked to steward	How important is it that stewards be present?	How important is it to have stewards who can provide information?
Shorebirds (Knots, birds)	28	3.45 ± 0.17	3.53 ± 0.17
Shorebirds and crabs	29	4.11 ± 0.17	4.03 ± 0.21
Horseshoe Crabs	22	3.85 ± 0.41	4.08 ± 0.38
Fish	69	4.25 ± 0.23	4.06 ± 0.36
Scenery and Tranquility	48	4.19 ± 0.31	3.50 ± 0.39
Recreation/other	64	4.17 ± 0.17	3.70 ± 0.24
X^2	21.0 (0.008)	10.63 (0.05)	4.91 (0.43)

Table 6. Effect of age on rating of the importance of having stewards that can provide information. The ratings went from 1 (not important) to 5 (very important). Given are the percent of interviewees for each age class for each rating of the importance of having stewards who can provide information.

	1	2	3	4	5	Mean Rating
Under 30 years	29	18	12	18	23	2.88 ± 0.39
31 - 45 years	13	0	21	30	36	3.77 ± 0.19
46 - 60 years	11	7	14	17	51	3.92 ± 0.16
Over 60 years	12	3	14	22	48	3.94 ± 0.14

Table 7. Gender differences in ratings concerning stewards, ecological protections, and research. Rating scale was 1 (not important) to 5 (very important). NS = not significant.

N = 279	Male	Female	X ² (p)
% Sample	53%	47%	
Rating of importance of each to Delaware Bay Beaches			
Stewards Present	3.75 ± 0.12	4.11 ± 0.12	4.07 (0.04)
Stewards Who Can Provide Information	3.71 ± 0.13	3.97 ± 0.12	1.74 (NS)
Protection of birds	4.73 ± 0.06	4.86 ± 0.05	3.52 (0.06)
Protection of horseshoe crabs	4.13 ± 0.11	4.21 ± 0.11	0.13 (NS)
Fishing	2.41 ± 0.14	1.95 ± 0.14	5.3 (0.02)
Research on migrant shorebirds	4.52 ± 0.08	4.59 ± 0.08	0.36 (NS)
Research on horseshoe crabs	4.01 ± 0.11	4.22 ± 0.11	2.39 (NS)

4.4. Information Needed

People also were asked what information they would like the stewards to provide. This was an open-ended question, and people could answer in any way they liked (Table 8). The full detail on the answer is presented because it can indicate the kinds of information that a stewardship program can address and consider providing in written form.

These data indicate 23% of people did not answer the question, and another 28% did not feel they needed information, or wanted information about the shorebirds and crabs. Among visitors there was a lack of information even about the presence of the stewards. Half of the people wanting information inquired where the shorebirds were currently feeding (e.g., what other Delaware Bay beach), or about shorebird migration and behavior. Far fewer wanted to know about the crabs, and even fewer wanted to know anything about the general ecology or other species living along the Delaware Bay shore. This provides an indication of the education potential for stewards (see below).

Table 8. Answers to the question—What would you like to know more about? It followed the question about whether people would like stewards who provided information. For this question, 65 people did not answer: percentages are based on 214 people who did answer. Many of the 65 people said they had never seen stewards or did not know what they were.

Comment	Number	Percent
Nothing	28	12
I know a lot already/learning on my own	9	4
Shorebirds/Knots		
Where they are now	45	21
General behavior	32	15
Migration/when in Delaware Bay	22	10
Population, survival, conservation	19	9
Life history/breeding	15	7
Identification	2	1
Horseshoe Crabs (only mentioned crabs)		
General behavior	23	11
Life history	7	3
Migration/when in Delaware Bay	5	2
How to tell if they are dead, how to flip	2	1
Medical uses and harvesting	2	1
Both shorebirds and crabs	5	2
General behavior/natural history	4	2
Where are they	3	1
Migration and breeding		
Ecology/natural history of the Bay ecosystem	12	6
Fishing	9	4
Baby turtles	5	2
Other comments:		
Where are stewards, and why don't they know more?	6	3
Where are Baby turtles going (e.g. terrapins emerging from winter)?	5	2

Continued

Where can kids play?	3	1
Where are the blue crabs?	3	1
Get rid of bugs.	2	1
Why not do a laminated field guide stewards can hand out?	1	<1
Awareness is more important than knowledge.	1	<1

5. DISCUSSION

There are several beaches along the New Jersey side of Delaware Bay that are used for foraging by shorebirds, including the federally threatened red knots. These beaches are vital to shorebirds because of the presence of spawning horseshoe crabs, which can provide an abundant source of eggs needed for the shorebirds to gain sufficient weight to continue migrating further north [5-7, 18-20]. Most of the beaches with easy access (e.g., at the end of roads) have beach stewards stationed at the road or beach point to prevent access to the foraging areas, while allowing the public to see the migration phenomena.

Many human activities disturb foraging shorebirds, particularly at key stopover sites during migration [17, 36, 37, 38-41]. It is equally apparent that using multiple management measures is important to protecting shorebirds and other coastal birds, and that few of these measures are based on effectiveness studies [38]. In previous studies we demonstrated that closures without either stewards or enforcement are ineffective—it only takes a couple of people who do not respect signs or listen to beach monitors to disrupt shorebird foraging [31, 33]. Further, in a similar interview study of visitors to a California beach used by wintering coastal birds indicated that most people did not think their activities impacted birds [19]. Having stewards at the beaches is a helpful way to communicate to people how their activities affect foraging shorebirds.

Our aim also was to understand the perceptions of visitors to beaches that are critical for foraging shorebirds. We found that talking to stewards, rating the presence of stewards (and stewards who provided information) depended upon visitor type, and that the reasons for visiting a given beach differed from the features that made them visit that particular beach. Age and gender also influenced perceptions. These issues are discussed more fully below. The types of information gathered in this study are generalizable to other shorebird and coastal bird environments, although the specific data may vary. Our study provides a template of the kinds of information to solicit. Our basic assumption is that involving visitors and other stakeholder in the development of stewardship programs will lead to more effective management that is accepted by both conservationists and managers [13, 42, 43].

To be clear, data from the Shorebird Project on New Jersey side of Delaware Bay indicate that stewardship program is successful—our objective is to make it even better and more effective in the area of public education. The implementation of signs, fencing, and stewards on shorebird beaches has enhanced the use of these beaches by red knots. This was determined by comparing the use of these beaches pre- and post-implementation [44]. There was a significant shift in the percentage of Delaware Bay red knots using the NJ site, where protection with signs and stewards was implemented in the early 2000s [44]. Thus, the protection program has increased the shorebird use of these beaches. Our intent in the present paper is to provide data to further improve the educational and stakeholder aspects of an already successful program.

5.1. Visitor Types and Interests

Understanding who the visitors are, why they come, and how often they come is essential information for management of the beaches during the shorebird migration season. The data from interviewing 279 people indicate that 60% of the visitors come to the Delaware Bay beaches in NJ to see the red knots, other

shorebirds, and/or horseshoe crabs. The others come mainly for recreation and fishing, and the scenery and tranquility the beaches offer. Some people drive to the beach, and merely sit in their cars gazing at the bay, the boats, the birds, and the vegetation.

The data in the present study illustrate that asking the same question in different ways (e.g., open-ended, choice, ratings) provide a clearer picture of the factors motivating people to visit these shorebird beaches. We found that the initial reason people stated for coming (e.g., shorebirds, crabs, scenery) was often the main reason they wanted to visit beaches, but their reasons for choosing a particular beach were often different. That is, they may have come to see shorebirds, to fish, or to see crabs, but the reason that they came to a specific beach often was for tranquility or scenery. This illustrates the importance of asking questions in different ways to understand the complexity of their motivations, and potential for education. If people come to a beach for tranquility, then managers need to maintain this aspect, which often means keeping visitors to a minimum (or managing noise and confusion), not having overdevelopment, and providing individual access. For some people the latter meant having no one between them and the crabs or birds (even when the birds were quite far away); they did not want to look over someone else's shoulder (although a thin rope at waist height was acceptable).

Many people did not feel they were disturbing the birds, which was a similar finding to LeCorre *et al.* [19]. They reported that the people interviewed put forth several different arguments to support their lack of effect on local bird populations. Our data, and those of LeCorre *et al.*'s [19], suggest that specific educational materials should be developed for each user group (see 5.3 below).

5.2. Evaluation of Stewards and Protection of the Shorebird-Crab Interaction

One of the main goals of the study was to determine the perceptions of people interviewed about the beach stewards, what types of information visitors would like, and what makes the beach more or less attractive. Both open-ended questions (people could say anything they wanted) and more structured questions were asked. The data indicate that 58% of those interviewed said the stewards helped, and 86% of those who answered the question said the stewards provided conservation value. However, 33% of the people interviewed did not answer whether stewards provided conservation value, and 40% of those interviewed said they rely on them for information. These data suggest that a significant proportion of people interviewed felt stewards were helpful, but many said maybe, I don't know, and no. Further, 22% didn't even answer the question about relying on stewards for information, and 56% of those that did answer, said no.

In light of these observations, it seems that many people feel the stewards are helpful both to themselves and for the birds, but others do not. Many people mentioned that they never saw stewards or did not know what they were, and others flatly said they were not helpful. Many felt the stewards were very helpful, and these views can be used to improve the stewardship program. Clearly, additional training of stewards, raising the awareness of visitors that there are stewards present, and encouraging both stewards and the public to interact are essential to a stewardship program and to shorebird conservation (see Antos *et al.* [45]). Additional training, funds, and visual/communication aids should be developed (see below).

Some people who visited several beaches (but were interviewed only during their first visit), later noted that the knowledge base varied greatly among stewards, as did the attitudes of the stewards. That the public can notice these differences suggests that stewardship programs can benefit from self-evaluations and group-evaluations where stewards share with one another (see below).

5.3. Recommendations for Improving Stewardship Programs

Human activities that disturb foraging or breeding activities can have an adverse effect on shorebirds [13, 35, 38, 41]. Identifying ways that human disturbances can be reduced is thus an important management goal. Beach stewards can play a key role in any management strategy but understanding the perceptions and incorporating the needs of beach users is critical [13, 38, 42]. Stewards have a unique opportunity to provide information to visitors to Delaware Bay during the shorebird migration season. The program

Table 9. Recommendations for improvement of the stewardship program. These are based both on the survey answers themselves, and discussions held with people after the interview. These are meant to improve programs that are already working.

Comment or suggestion	Recommendation/Possible Actions
Stewards were not present	Establish a set time of steward presence; post these at each site.
Stewards were not obvious	Post stewardship hours, when present, identify stewards on a signboard, and with large badges.
Stewards are not close to where I park	In some cases, there is a walk to the beach from parking areas. If these are natural areas (e.g., not roads/sidewalks), then at parking areas, signs should identify the presence and location of a steward.
I can't find the stewards	Obviously if only one steward is assigned to a given beach, they need to take a bathroom break—information on when stewards will return should be available.
Stewards curtailed my activity	Posted boards should clearly identify WHY people cannot go onto the beach and cannot have wandering dogs.
Stewards are not respectful of locals	This is an environmental justice issue that needs to be discussed openly by supervisors with stewards; the importance of local support during the shorebird season, and the rest of the year should be stressed. Locals especially should be given time, care and information.
Stewards are not respectful of people that are fishing or have children.	Fishing is a year around activity in many places and ensuring support for natural resources throughout the year is an important message, and stewards should be especially respectful to year around residents. Children are our best chance to change the future.
Can my children touch the crabs	This is an issue that supervisors should discuss with stewards and provide as many opportunities for children (and adults) to experience the crabs (particularly at places where crabs are inshore on the section of beaches for visitors (e.g. ends of streets at access). Written information suitable for children should be provided on crabs and the shorebirds.
Can stewards provide information on where the knots or other shorebirds are	This can be addressed by setting up a system where all stewards can have information from the local authorities (in the present case from the “Knot Team”) about the location of the shorebirds.

Continued

How do I find information on knots, other shorebirds or crabs	<p>Many people asked questions about natural history of shorebirds or crabs. A general information packet on natural history is available from the state but is generally not widely distributed. Perhaps stewards should offer these sheets to visitors if they express interest.</p> <p>A signboard should be available for each steward with basic information and pictures of the key shorebirds.</p> <p>A dedicated website should be available that stewards can refer to for general information on natural history, crabs, harvesting of crabs for bait and medical purposes, and the bay ecosystem. It could provide data on past population shorebird numbers. This site should be available on the steward's signboard, with a QR code.</p>
How can I help the shorebirds	Sign boards should include the key conservation information
Why do I have to stay off the beach?	This should be covered briefly on the steward's signboard, along with other key information.
Where else can I go to see them?	Stewards should have maps of the key beaches for Red Knots and other shorebirds along Delaware Bay (although these are available, they were not made available to the people interviewed).
How do I know when to find the shorebirds?	Stewards should be provided with information on the tides, and the relationship between tide times and shorebird behavior. It's discouraging for people to come at low tide and have the birds a mile out on a shoal.
How can I become a steward	Again, stewards should be quipped to provide information on how to become a steward or help in some other way.

Table 10. Further recommendations generated from interview data, interviewer impressions, and the authors.

Data-driven Concept	Recommendation
Visitor type differs	Different visitor types rated different aspects of the shorebird and crab protection program differently. Stewards and education efforts should directly address each type.
Gender differences	Women often spoke more to stewards and rated them more highly, suggesting that added attention should be devoted to addressing the specific interests of male visitors, and in education materials that they relate to, including fishing.
Age-related differences	The rating assessing steward's knowledge increased with age of the person being interviewed. This suggests that young people find information from other sources, like online descriptions. Developing a phone app devoted to Delaware Bay shorebird conservation or adding information to project partner's websites would help stewards reach most people, including younger age classes.

Continued

Conviction that they do not disturb birds	This is a common issue—People see that they have little effect, while not considering the collective impact of many people’s minor disturbances. An easily understood info-graphic along with information on the known impact of disturbance to shorebirds (reduced time spent feeding etc.) would help stewards address this important point.
Higher ratings for shorebird conservation/research than for crabs	The connection between crabs and shorebirds, although seemingly clear to stewards and others, is not always clear to the public. Stewards should be encouraged to discuss the critical nature of crab eggs and their role in shorebird survival and reproduction. They should be supported with easily understood graphics in a concise brochure
Inadequate steward education	Some interviewees mentioned that when they visited different beaches, the stewards had different levels of education. This suggests a strong need for a more robust pre-season education session(s) and training so that stewards are empowered to be the local experts (not just police). Training for new volunteers could be helped with mentoring from existing stewards.
Inadequate steward props and materials	Stewards should all be equipped with identification tags, chairs, umbrellas, sign boards, printed materials, and a smile. The stewardship program should be adequately funded so that stewards have pride in their ability to explain the crab/shorebird interaction and the bay ecosystem
Steward group sessions on information and best practices	Having a session or two during the shorebird migration period where stewards can share information and best practices could improve moral and information (could be done by zoom).
Local information	Many people who are first time visitors to Delaware Bay do not know where to park, whether they can touch crabs in the locations where people are allowed, where they can get coffee, food or a bathroom. It would be easy for the stewards to be provided with a one-page information sheet on some logistical information.

has proven successful in that the majority of red knots, a species known to be sensitive to disturbance, used beaches protected by stewards in NJ. Delaware Bay beaches in Delaware do not restrict public access to beaches used by red knots. It is important for stewards to recognize how important they can be not only as ambassadors of the shorebird-crab managers and scientists, but to the functioning of the shorebird stop-over, the overall ecosystem of the Bay, and the conservation of the system. This message of value should be transmitted clearly to the stewards through intensive steward training and in materials provided to the public. One of the main objectives of the study was to find out the perceptions of visitors with the hope of using the information to improve the program.

Many of the visitor’s suggestions dealt with where or when were stewards present, others dealt with information needs, while still others dealt with logistics (where can I park, how do I know it’s alright to park here, and where is the bathroom?). These are addressed easily, but stewards should know where the

closest place is that visitors can buy a bottle of water or cup of coffee and find a restroom. Informing the stewards about the issues mentioned in [Table 9](#) is as critical as having them there. They are the ambassadors for the local, state and regional conservation and resource managers, and they should be treated with upmost respect and appreciation—just as the visitors should. We note that there were three kinds of recommendations from visitors: 1) Lack of knowledge of steward or complains about them, 2) Quests for more information, and 3) Questions about how they can become involved or help ([Table 9](#)). We add a fourth that comes from our conversations with them and from the data ([Table 10](#)).

Many of the above conclusions and suggestions mandate that stewards receive more detailed and clear training prior to the season, the tools to identify themselves, information brochures to provide to the public, and adequate chairs, story boards or whatever is essential to provide information to the full range of people from those visiting for the first time to those people familiar with the shorebird migration-crab spawning spectacle. It also requires that stewards be there consistently (and post when they are taking breaks and when they will be back).

Other recommendations come from the interactions of the interviewers with people visiting the beach. Particular questions often elicited responses way beyond the survey itself. Further, at the end of the survey, informal conversations provided additional insights for improving the stewardship program ([Table 10](#)). On a personal note, the senior author found that nearly everyone was willing to be interviewed, and the more relaxed and open she was, the more people wanted to know more about the knots, shorebirds, threats they faced, and the Bay in general. The better trained and knowledgeable the stewards, the better communication will be. The importance of steward's understanding the different reasons people come is critical because people who came for reasons other than shorebirds and crabs were quite interested and wanted more information about the shorebirds, if encouraged. This group of visitors could be shown the importance of the beach and its protection for the shorebirds that are truly an international treasure, as well as being threatened. The stewards are in a unique position to greatly influence the visitors to Delaware Bay, improve their knowledge, and further the conservation of the Bay ecosystem.

Finally, our recommendations are aimed at improving the stewardship program at beaches where shorebirds and other coastal birds forage. The stewards, however, are the public face of the stewardship program. It is critical to remember that planning, implementation, funding, and logistical support for the program needs to be provided and sufficient so that all the stewards at each beach are equally prepared themselves and armed with education tools to enhance the public's understanding of not only the shorebird and crab interactions, but the health and well-being of the Delaware Bay ecosystem.

6. SUMMARY AND CONCLUSIONS

Many species of shorebirds, including the federally threatened red knot, migrate long distances between breeding and wintering ground, and make very few stops along the way to refuel. With increasing development in coastal areas, and increasing sea level rise, the essential habitat for foraging shorebirds is declining. Declines in red knots were partly attributable to declines in available eggs of horseshoe crabs, their main prey during spring migration through Delaware Bay; disturbance by people enhances egg shortages by preventing birds from foraging or forcing them to use up energy when avoiding people. Because of declines in red knot populations, and the effect of human disturbance on foraging birds, nearly all beaches important to shorebirds and horseshoe crabs along New Jersey's Delaware Bay shore had restricted access during May and early June, and stewards monitored the main shorebird foraging beaches. We examined the perceptions of visitors to these beaches with in-person interviews.

Slightly more than half of the visitors coming to the beach came to see the shorebirds, crabs, or both—but that means that 40% came primarily for other reasons—to see particular beaches for scenery and tranquility as well. Only 58% of people interviewed said that stewards helped—which suggests there is room to improve the stewardship program with the public. People also rated the protection of (and research on) shorebirds and crabs higher than they rated stewards, also suggesting the need to enhance the relation between the stewards and conservation efforts. Visitors rating the information value of stewards

varied as a function of visitor type, age, and gender. For example, people who came for the scenery and tranquility rated the importance of stewards higher than did others, women rated them higher than men, and older people rated them higher than younger people.

Importantly, the people interviewed provided insight into how to improve the stewardship program, including the types of information they would appreciate, and what would improve their experience at the beach. Suggestions for improvement included making sure stewards were present, visible, and approachable, that they were equipped with information on the whereabouts of the knots, other shorebirds, and crabs, and about the ecology and biology of the interactions. But these public stakeholders also wanted logistical information about other shorebird viewing locations, amenities, and where they could touch crabs. From our perspective, the stewardship program can be much improved by an infusion of information tools and mechanisms, better coordination so that stewards always know where shorebirds are currently feeding, and sufficient funding to provide the education and tools for stewards.

The efforts of the Shorebird Protection Program on Delaware Bay have been successful in protecting red knots and other shorebirds. These data and suggestion can help improve the Delaware Bay shorebird protection program, making it more robust, with more funding, and with a stronger educational component. Further, these data can contribute to enhancing stewardship programs all along the Atlantic and other coasts.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

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