SHOREBIRD AND BOATER IMPACT MANAGEMENT PLANNING

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This paper integrates social and ecological impact data from a barrier beach to demonstrate the value of an inter-disciplinary approach to resource allocation and visitor management. The ecological data included observations of shorebird distributions and causes of human disturbance. The social data were obtained from on-site surveys of boaters and pedestrian visitors. The ecological findings indicated that shorebird habitat preference was limited to two of the four areas where boaters were present. The social data indicated that some boaters engaged in activities that caused shorebird disturbance, and were not ecologically aware of their impacts. A management plan was developed to restrict boaters from areas used by shorebirds. Educational programs were developed to increase boater awareness of the impacts they cause.

Introduction

Stretching along the U.S. Atlantic coast from New England to Florida are a series of sandy islands and beaches. These fragile and dynamic ecosystems, consisting of sand, shell, and gravel, provide a protective barrier along 2,700 miles of shoreline. Wind, tides, and ocean waves constantly move sand and change the size and shape of barrier beaches, as they buffer their wetlands and the mainland from the forces of nature. Coastal barrier habitats include open ocean beaches, broad salt marshes, and dense forests which support a variety of flora and fauna. Salt marshes, for example, are nurseries for many ocean fish which would not exist without the protection afforded by coastal barriers. Migratory shorebirds depend on barrier beaches for feeding, nesting and resting habitat.

Although rich in natural resources, coastal barriers are susceptible to human activity and developmental pressures. Due to their exceptional scenic quality and proximity to large urban centers, barrier beaches along the east coast attract millions of visitors each year. This demand for recreational access has increased the potential for deleterious consequences. Recreation activities can disrupt coastal processes, destroy the ecological integrity of the coastal barriers and reduce the quality of the visitor's experience. In recognition of these potential problems, public concern over protecting these environments has grown dramatically in recent years.

Unfortunately, despite decades of ecological research, the tools for managing coastal barriers remain to be fully developed (Ray and Gregg 1991). This paper examines a program of research and management initiated by The Trustees of Reservations (TTOR) at Crane Beach in Ipswich, Massachusetts. Findings from social and ecological impact studies are used to demonstrate the value of an inter-disciplinary approach to resource allocation and visitor management. The goal was to develop a visitor impact management plan that recognized the existing impact of visitors on shorebirds and made recommendations to mitigate such impact. We begin by briefly reviewing the ecological and social impact literature.

Shorebird Impacts

Information on the effects of recreation on shorebirds is incomplete. Findings are often mixed and the responses to human intruders are divergent, even in a single species (Ream 1980). The impacts of recreation activity can be a direct result of harassment of shorebirds, or can occur indirectly through the loss of habitat, food supply or productivity (Ream 1979, Cairns and McLaren 1980, Haig and Oring 1985, Sidle 1985, Flemming and others 1988).

Direct shorebird harassment includes events which cause excitement and/or stress, disturbance of essential activities, severe exertion, displacement or death. Recreationists engaged in nonconsumptive activities can have a major impact on nesting shorebirds by unknowingly producing stressful situations for the birds (Wilkes 1977, Ream 1979). Piping plovers (*Charadrius melodus*), for example, nest on or just behind the sandy beaches. Because the nests blend in to the sand, plovers are prone to accidental human disturbance. Piping plover chicks are unable to fly for several weeks after hatching, but do leave the nest site with parents and travel along the high tide line in search of food. The chicks blend in well with the sand and are especially vulnerable to Off-Road Vehicles (ORVs). Findings from Cape Poge-Wasque (Swanson 1990) and Coskata-Coatue (Litchfield 1990), two barrier beaches managed by TTOR, indicated that ORVs frequently disturbed nesting sites and altered the behavior patterns of piping plovers.

While ORVs can impact shorebirds directly by destroying nests and possibly killing some birds, the vehicles also affect the birds indirectly by compacting the sand and reducing their food supply (Kuss and others 1990). When the ground flora are lost to trampling, the insects dependent upon the flora also disappear (Speight 1973).

Other research on least terns (Blodget 1978), shows that the shorebirds response to vehicles may be less than that resulting from foot traffic. Controlled experiments using ORVs and pedestrians demonstrated that ORVs had significantly less impact on birds flushing from nests. Vehicles could come twice as close to sitting birds before they would fly than people on foot (Blodget 1978). When the nesting areas were well marked and protected, the birds developed a high tolerance level for ORVs passing close to the nesting areas.

Human disturbance on birds has been shown in some investigations to result in reduced productivity rates and species decline. Disturbing nests causes adults to fly off, leaving eggs vulnerable to hatch failure or predation (Garber 1972, Hunt 1972, Bart 1977). Studies conducted along the Atlantic coast suggest that mammalian and avian predation has severely

limited nesting success and the size of piping plover populations (Cairns 1982, Ailes 1985, Rimmer and Deblinger 1990, Litchfield 1990, Swanson 1990).

Overall, the available empirical evidence highlights the complexity involved in understanding recreational impacts on specific shorebird populations. Among certain species of shorebirds, encounters with even a few humans can alter behavior patterns and influence productivity and survival rates.

Visitor Perceptions of Shorebird Impacts

How visitors perceive impacts on shorebirds is not well documented. Available evidence suggests perceptions of the impact varies among different user groups and different locations. At Cape Poge-Wasque, for example, pedestrian visitors were more likely to recognize the impact of humans on shorebirds than ORV users (Donnelly and Vaske 1989, Deblinger and others 1989). At Coskata-Coatue, ORV visitors were more likely than Cape Poge-Wasque ORV users to think 4-wheel drive vehicles harm the shorebirds (Donnelly and Vaske 1991).

Other comparisons between the pedestrian and ORV users at both Cape Poge-Wasque and Coskata-Coatue show that nearly three quarters of all respondents thought managing for wildlife was more important than managing for other uses. Consistent with this belief, visitors at these two barrier beaches felt a personal obligation to protect the birds, and were willing to reduce the number of their visits to achieve that end (Donnelly and Vaske 1989, 1991).

These observations from two barrier beaches, when combined with data from other natural environments (Lucas 1979; Graefe and others 1984; Kuss and others 1990), suggest three aspects of the impact issue: (1) recognition of the impact, (2) perceived importance of the impact relative to the other attributes of the setting, and (3) evaluation of the impact condition as acceptable or unacceptable . Resource impacts may be recognized or unrecognized by the user (Cole and Benedict 1983). If recognized, the effects may be minimal if the impact is unimportant relative to other setting attributes (e.g., amount of area for sunning), or if the impact is acceptable to users.

In summary, the challenge for barrier beach managers is to develop management plans, based on an understanding of ecological and social relationships, which minimize human impact on shorebirds while providing opportunities for recreation activities (Deblinger and others 1989). The following examines the strategies adopted by TTOR at Crane Beach.

Study Site

Crane Beach is a portion of the 560 ha Richard T. Crane, Jr. Memorial Reservation that also includes a wooded and landscaped drumlin estate. The beach is 6 km in length and is located between the mouths of the Ipswich and Essex rivers. Habitats include fine sand beach, salt marsh, red maple swamp, cranberry bog and pitch pine forest. Crane Beach also provides nesting, feeding and resting habitat for migratory shorebirds.

Numerous species of shorebirds stop over at Crane Beach to rest and feed as they migrate from Canada and the Arctic to southern climes such as the Caribbean and South America. The most abundant species include Sanderlings (*Crocethia alba*), semipalmated plovers (*Charadrius semipalmatus*), semipalmated sandpipers (*Ereunetes pusillus*) and black-bellied plovers (*Squatarola squatarola*). The timing of their arrival at Crane Beach (July, August and September) corresponds to the peak visitor use times.

Crane Beach receives approximately 400,000 visitors per year. Visitors arrive by car at a centralized parking lot or by boat anywhere along the beach except at a lifeguard patrolled swimming area (Deblinger 1991).

Essex End of Crane Beach

Essex End of Crane Beach is used by both boaters and shorebirds. For research purposes, we separated the Essex End into four sub-sections: outer beach, inner beach, steep beach and sand spit. The outer beach is located on the Atlantic Ocean side of Crane Beach, extending 300 m to the north and is adjacent to the sand spit to the south. The outer beach is relatively wide from the low to high tide line with an extensive dune system behind. The sand spit is located at the extreme southern end of the property and is an area that receives daily flooding, the extent of which depends on the tidal cycle. Generally, the sand spit is covered by water during high tide. The steep beach is located to the west of the sand spit and receives its name from the steep incline of the beach below the high tide line. This area provides an excellent natural dock for boats. The steepness of the beach allows a boater to anchor a boat to shore without fear that it will touch bottom as the tide goes out. The inner beach is located on the Essex River side of the property and is composed of a very wide mud flat. In contrast to steep beach, the inner beach slope is gradual, creating a wide mud flat during low tide.

Methods

Both ecological and social research methodologies were used to describe the magnitude of impact and evaluate acceptable mitigation strategies.

Ecological Procedures

Two researchers observed shorebird distributions, abundance and behavior at 30 minute intervals while overlooking the Essex End from a promontory atop a sand dune. Observations were made five days a week including three weekdays and both weekend days, weather permitting, from 3 July to 13 September, 1990. The average duration of observation was six hours. Approximately 200 hours over 41 days were spent observing shorebirds.

Because shorebird distribution and behavior are related to tides (Burger 1981), hours of observation varied according to the tidal cycle. Observations were conducted three hours before and three hours after high tide. Direct counts of shorebirds, people, boats, dogs, TTOR trucks and all terrain vehicles (used by rangers) were recorded before, during and after high tide at each area. The cause and duration of shorebird disturbance were also measured. Disturbance was defined to occur when more than 50% of the birds in a flock took flight.

Social Procedures

A visitor survey was conducted at Crane Beach during the summer of 1990. A total of 174 boaters completed the two-page self-administered questionnaire. Only one member from each boat was interviewed.

The survey contained questions pertaining to the boaters: 1) knowledge of ecological impacts on shorebirds, 2) beliefs about the appropriate number of visitors, and 3) evaluations of current management practices.

Results

Shorebird Ecology and Behavior

A total of 20 species of migratory shorebirds were observed using Crane Beach for feeding and resting. Many of these species, however, were present in low numbers. Only four species reached numbers greater than 100 during any one census period. These four species - semipalmated plovers, black-bellied plovers, semipalmated sandpipers, and sanderlings - are the focus of this paper.

Shorebird distributions varied significantly ($F = 12.06$; $p < .001$) according to location and tide (Fig. 1).
On average, however, the shorebirds preferred the tidal flats on the inner beach for feeding (Table 1). As the tide increased, most of the shorebirds on the feeding flats moved above the high tide line to rest along either the outer beach or the sand spit. Sanderlings, the one exception, preferred the outer beach for both feeding and resting. Steep beach, the area with the greatest concentration of boaters, was almost never frequented by the shorebirds for either feeding or resting. These behavior patterns were independent of the presence of boaters. The shorebirds preferred the beaches with the gradual inclines for feeding and resting, while most of the boaters preferred the steep beach with its good anchorage.

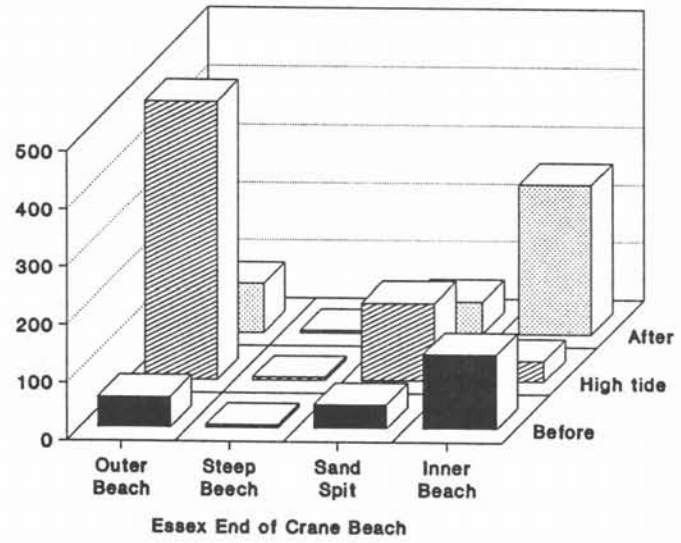

Figure 1. Shorebird distributions.

Table 1. Shorebird and visitor distribution patterns.

Average Number:	Outer Beach	Steep Beach	Sand Spit	Inner Beach
Semi-palmated plovers	81.4	0.8	27.3	77.9
Black-bellied plovers	7.9	0.1	2.3	5.9
Semi-palmated Sandpipers	101.2	3.8	42.5	48.3
Sanderlings	33.4	0.5	9.1	1.7
Boaters	13.9	40.3	13.4	3.0

Human Use

The maximum number of boats observed at one time was 163, with 143 anchored off steep beach. Once visitors anchored their boats, they walked to shore to recreate. Most visitors remained within close proximity of their boat while sunbathing or picnicking. The maximum number of visitors recorded was 461. Of that, 54% occurred at the steep beach, 25% at the outer beach, 19% at the sand spit, and 3% at the inner beach.

Shorebird Disturbance

Shorebird disturbance was defined to occur when more than 50% of the birds in a flock took flight. Determining the cause of disturbance was usually difficult to precisely identify. Of the 627 observed incidences of disturbance, 53% were for unknown reasons, 6% were caused by natural factors such as predators, and 41% were human induced. The largest single cause of disturbance (33%) was pedestrian encroachment into a shorebird area.

The frequency and duration of shorebird disturbance varied greatly. While the frequency of disturbance was related to the number of visitors, duration of disturbance was influenced more by predators than visitors. Of the 294 disturbances with a known cause that were observed throughout the study period, duration ranged from 45.7 seconds for pedestrians to 106.7 seconds for raptors.

Boater Beliefs about Impacts

A number of the survey items addressed the visitors' awareness of the ecological impacts. Nearly 90% of the boaters at Crane Beach recognized that barrier beaches are fragile environments (Table 2). Over three quarters agreed with the general statement that managing for wildlife was more important than managing for other uses. Fewer than half, however, felt that preservation is more important than recreation at Crane Beach.

Table 2. Boaters' beliefs about shorebirds impacts.

Belief	Boaters Agree (%)
Crane Beach is a fragile environment	88
Managing for wildlife is more important than managing for other uses	76
Preservation of natural resources is more important than recreation at Crane Beach	48
More measures should be taken to protect shorebirds	79
Boaters landing at Crane Beach are harmful to the shorebirds	31
I feel a strong personal obligation to protect the shorebirds	92
I would be willing to reduce my visits to Crane if it would help to protect the birds	42

Although three quarters of the boaters believed more measures should be taken to protect shorebirds, less than a third thought they were harmful to the birds. Similarly, while nearly all boaters (92%) felt a strong personal obligation to protect the

shorebirds, only 42% were willing to reduce the number of their visits to help protect the birds.

Other survey items concerned the boaters' beliefs about social considerations (Table 3). Fifty-five percent believed Crane Beach is approaching the limit of the number of *people* the area can tolerate. While nearly three quarters thought the number of *boats* was approaching a tolerance limit, only about a third favored restricting the number of boats permitted to land on the beach. A similar percentage agreed to prohibiting boats from designated swimming areas.

Table 3. Boaters' beliefs about social impacts.

Belief	Boaters Agree (%)
Crane Beach is approaching the limit of the number of:	
people the area can tolerate	55
boats the area can tolerate	71
It would be more desirable if the number of boats were reduced at Crane Beach	36
Boaters should be restricted to designated no swimming areas	38

Visitor Impact Management Planning

The Trustees of Reservations fundamental mission is to preserve for public enjoyment places of exceptional scenic, historic or ecological value throughout Massachusetts. More specifically, the goal is to protect endangered shorebirds and fragile dune systems from the impact of human use, while simultaneously providing opportunities for recreation activities. In light of this objective, the results from the ecological and social research were used to develop a management plan at Crane Beach.

Findings from the shorebird research indicated that predators were causing greater impact than the visitors. Two types of protection were applied to mitigate these impacts. Small wire-mesh fences were installed around nests to protect piping plovers from skunks, raccoons, foxes, gulls and crows. Outside of these exclosures, symbolic fencing composed of a single strand of twine was erected to eliminate disturbance by visitors. These areas were posted with signs to educate visitors about nesting shorebirds.

The Crane Beach shorebird disturbance study indicated a natural zoning existed between visitors and the birds. Most boaters were attracted to a portion of the beach which, due to habitat considerations, the birds did not use for either feeding or resting. By designating restricted boat landing areas outside of the feeding flats and restricting visitors from bird resting areas in dunes, migratory shorebirds could stop over at Crane Beach undisturbed.

The social research indicated that the beliefs held by some of the visitor groups conflicted with the management goals. Comparisons of questionnaire responses between the boaters and another survey of pedestrians at Crane Beach (Deblinger 1991), for example, revealed a clear distinction. Boaters were less educated about property regulations and human impact. At Crane Beach, pedestrian visitors enter via a gatehouse where they receive educational information. Conversely, boaters land at many sites along the beach where educational information is unavailable. The management plan designated boat landing areas where boaters would receive educational information, be segregated from swimmers to promote safe recreation, and be segregated from wildlife and dunes.

The social research results also indicated that a majority of the visitors felt that Crane Beach was approaching its tolerance limits for both boats and people. In response to these findings, designated boat landing areas were specified to segregate the boaters from the swimmers. While current use levels do not necessarily warrant restricting visitor numbers at this time, future research and planning will monitor shifts in these baseline data.

Discussion

Early in the study, it became apparent that the majority of shorebirds were using Crane Beach for a resting area during high tide. Moreover, the tidal cycle explained shorebird distribution and behavior patterns. Shorebirds were located on the feeding flats (shallow sloped beaches) below the high tide line before and after high tide. During high tide, they shifted distribution to the sand dunes above the high tide line along the outer beach. The steep beach used by boaters for safe anchorage was not used by shorebirds. A natural spatial separation, therefore, segregated the visitors from birds. The management plan reinforced this natural zoning by designating a boater landing area, consistent with the location used by most boaters.

As for frequency and duration of disturbance, fencing and signage were used to restrict onshore visitors' activities to an area beyond the flushing distance from shorebirds. Offshore boater activities did not disturb resting or feeding shorebirds.

Boaters that landed at Crane Beach were less aware of the fragility of barrier beaches and their natural inhabitants than visitors that accessed the property through the parking lot entrance. The visitor impact management plan established education programs to increase the boaters awareness of the impacts they can create.

Although ecologists continue to search for solutions to protect fragile dune environments and increase endangered shorebird populations, it is apparent that information regarding visitor attitudes must be combined with ecological data. At a time when the public's thirst for barrier beaches as recreational sites or locations for summer houses seems unquenchable, management strategies, such as beach closure, that do not include visitor attitude information may be deleterious to barrier beach environments in the long run. Conversely, the combination of visitor education and management techniques that balance preservation with recreation can result in a situation where the environment can be protected from recreationists and predators, and the visiting public can still enjoy the area.

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