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Assessing the spatial compatibility of recreational activities with beach vegetation and wrack in New Jersey: Prospects for compromise management

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ABSTRACT

This study examines the prospects for compromise management to support greater natural resources on recreational beaches by analyzing the spatial dimensions of key natural resource indicators (beach vegetation and wrack) with peak recreational uses in New Jersey, one of the most intensively developed shorelines in North America. The spatial distribution of pedestrian and vehicular recreational uses was measured on 60 transects in heavily-populated beaches during the peak times and days of use during the summer tourist season, and compared to that of vegetation and wrack on 72 transects in nearby protected natural areas. The frequency, density, and % use were calculated for each 10% increment of linear beach surface, and the impacts of protecting different amounts of upper beach areas were calculated in terms of the % vegetation, wrack and recreational use that would be supported in each case. Vegetation was highly concentrated in landward portions of the beach surface, and pedestrian and parked recreational vehicles in the seaward areas, suggesting high compatibility of these natural resources with recreational use. Lower compatibility was found for existing patterns of wrack and vehicle driving, which were more widely distributed across the beach surface. Based on the distributions of these variables, protecting the upper 50% of the beach would support >80% of vegetation, pedestrian and parked vehicular uses, and 42–52% of driving uses and wrack, respectively. Protecting the upper 25% of the beach would support >95% of all recreational uses, 52% of vegetation, and 24% of wrack. Given the current level of impacts to vegetation and wrack on recreational beaches, major gains in these and other natural resources can therefore be made across the shoreline without substantial impacts to existing pedestrian or vehicular recreational uses. Greater ecological benefits and ecosystem services may be obtained by applying these types of compromise management solutions to recreational ocean beaches in the future.

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1. Introduction

Human populations are highly concentrated in the coastal regions of the planet (Crossett et al., 2004; Small and Nicholls, 2003), and their uses of ocean shorelines place significant pressures on coastal natural resources. Recreational beach uses and associated management activities (e.g., beach cleaning, off-road vehicles) may severely damage or disrupt the structure and function of beach ecosystems, impacting beach flora and fauna, wrack, sediment, and beach topography, and the various biological and physical processes associated with them (Rickard et al., 1994; Watson et al., 1996; Dugan et al., 2003; Schlacher and Thompson, 2008; Deidun et al., 2009; Dugan and Hubbard, 2010; Nordstrom et al., 2011; Roig-Munar et al., 2012; Kelly, 2014). Sustainable solutions are needed that balance recreational interests with natural resource concerns across the coastal landscape; i.e., reducing the environmental impacts of human activities while still respecting cultural and economic uses. This study examines the spatial distribution of recreational activities and upper beach habitat characteristics in New Jersey in order to determine the potential for satisfying both of these interests through compromise management solutions on recreational shorelines (Nordstrom, 2003).

Although effective conservation of all natural resource characteristics is impossible where intensive recreational uses of the beach surface occur (McLachlan et al., 2013), spatial variation in the

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concentration of those uses may provide a basis for establishing intermediate levels of protection. Most recreational activities (e.g., sunbathing, swimming, fishing), for example, are concentrated in the seaward portions of the beach surface (Watson et al., 1996; Valdemoro and Jimenez, 2006; Guillen et al., 2008), whereas many important habitat conditions are concentrated in the landward portions of the beach above the reach of high tides, such as beach plant communities, embryonic dunes, and shorebird and sea turtle nesting sites (Colwell et al., 2005; Maslo et al., 2010; NMFS and USFWS, 1991; Kelly, 2014). However, this balance of recreational and natural resources values is not typically achieved because of the broader impacts of beach maintenance and other activities peripheral to the primary recreational uses. In New Jersey, for example, vehicle driving and mechanical raking impact an average of 79% and 100% of the beach surface where they occur, respectively, translating into dramatic reductions and/or elimination of beach vegetation cover and wrack (Kelly, 2014). By changing the patterns of these uses and restricting them to the specific areas needed to support recreation, much greater areas of upper beach habitat might be protected throughout the shoreline at little or no cost or loss of recreational use.

Beach vegetation and wrack provide useful indicators of ecosystem integrity and natural resource values given their high visibility, their sensitivity to human impacts, and their integral relationships and/or spatial correlation with a variety of important shoreline patterns and processes, including sediment stabilization, dune development, and habitat for wildlife and endangered plant and animal species (Watson et al., 1996; Weakley et al., 1996; Dugan et al., 2003; Deidun et al., 2009; Maslo et al., 2010; Nordstrom et al., 2012; Kelly, 2013, 2014). Although it would not necessarily preserve all aspects of natural beach structure and function, protection of upper beach areas could result in substantial increases of natural resources and ecosystem services in recreational areas where little to none currently exists.

These concerns are especially relevant to developed coastlines, where human population pressures are greatest and the losses of natural shoreline features are most extreme. New Jersey, for example, has the highest population density in the United States and the highest coastal population density of any oceanfront state (Crossett et al., 2004). More than 20 million people live within 100 km of its shoreline, including the populations of nearby New York City and Philadelphia (U.S. Census Bureau, 2013). Tourism generates more than $35 billion annually in New Jersey, the greatest portion coming from its coastal counties (Tourism Economics, 2013), where dense residential and commercial development allows for local populations to increase several-fold during the summer tourist season (Monmouth County Planning Department, 2008). As a result of these pressures, 70% of New Jersey beaches are currently impacted by intensive recreational uses and associated maintenance activities; 92% outside of the three largest protected areas (Island Beach State Park, Forsythe National Wildlife Refuge, and Sandy Hook) (Kelly, 2014).

Given the value of beach habitats for species conservation, dune development, and other ecosystem services described above, greater benefits to coastal communities could clearly be obtained by better integrating them on recreational beaches whenever possible. This study attempts to assess the spatial dimensions of recreational activities at their peak levels of use and compare them to beach vegetation and wrack in areas where these activities do not occur, in order to more clearly discern the degree to which these natural resources may be supported on recreational beaches. By focusing on periods of peak use during the summer tourist season in one of the most densely developed ocean shorelines in North America, this study should find broad applicability to other coastlines where these types of recreational activities occur at similar or lower intensities.

2. Methods

The particular portions of the beach that were the focus of this study were the beach surface from the base of the foredune to the berm crest, where the beach angles more steeply toward the surf or foreshore, and includes both the supratidal and upper intertidal zones as identified by Godfrey and Godfrey (1981; Fig. 1). This area roughly corresponds to the backshore, upper beach, high beach or back beach areas described by other authors (Breden et al., 2001). In New Jersey, beach vegetation is typically restricted to areas above the reach of high tides, and consists primarily of pioneer plant communities dominated by sea rocket (*Cakile edentula*) and other annual species (e.g., *Salsola kali*, *Chamaecyse polygonifolia*); identified by Breden et al. (2001) as the "*Cakile edentula* Sparse Vegetation Alliance." Numerous other synonyms exist for these plant communities, typically referring to their location or functional relations to dune development and/or wrack deposits (Kelly, 2014). Dune vegetation, dominated by American beachgrass (*Ammophila breviligulata*) and other perennial species is also mixed with the beach vegetation described above in many situations, indicating the lateral expansion of the adjacent dunes or development of incipient dunes on the beach surface, but was not differentiated in this study.

Data on vegetation, wrack, and recreational use patterns were collected on transects in representative portions of the 209-km state shoreline from 2003 to 2005 (Fig. 2). Transects were arranged perpendicular to the coastline, with the zero point positioned at the berm crest and extending inland to the base of the foredune or other structure delimiting the end of the beach. The positions of any wrack and beach vegetation occurring within 25 m to either side of the transect line (effectively amounting to a belt transect 50 m wide) were recorded in terms of distance from the berm crest when present/identifiable. Transects were spaced an average of 500 m apart within each of the respective areas. Qualitative confirmation of the generality of these patterns in other areas and years in New Jersey was made during annual surveys of the entire state shoreline for rare beach plant species from 2001 to 2014 (Kelly, 2013, 2014).

Data on the spatial distribution of vegetation and wrack were collected on 72 transects in protected natural areas in all four coastal counties (Monmouth, Ocean, Atlantic, Cape May) in 2004–2005 (Fig. 2). Surveys of recreational beach activities were collected on peak times and days in the tourist season in 2003–2004, among the most heavily utilized portions of the coastline in order to effectively document the maximum levels of use taking place on these beaches (i.e., when and where the least area of unused beaches were likely to occur). These included major holidays (Independence Day – July 4th, Labor Day – 1st Monday in September) and other weekends from late June through August for pedestrians, and through early October for vehicles, when the weather was sunny and warm, between 10 AM and 3 PM. Surveys of pedestrian uses were conducted along 33 transects in the following major tourist destinations: Ocean Grove, Bradley Beach, Avon-by-the-Sea, Point Pleasant, Seaside Heights, Seaside Park, Island Beach State Park, Ship Bottom, and Beach Haven (Fig. 2). Transects were spaced an average of 500 m apart, with two or three located in each locality, and surveys taking place on multiple dates in the first four locations. Transects were placed in the most populated pedestrian areas occurring within each of these locations, and were positioned in the same manner as the vegetation transects above. The number of beachgoers were scanned and recorded for each segment of the beach surface, including all people occurring within 25 m to either side of the transect line. The number of people below

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