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Facilitating landform migration by removing shore protection structures: Opportunities and constraints

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ABSTRACT

Recent studies have identified the need to adapt to climate change by allowing landforms and habitats to migrate landward, although implementation of actual adaptation responses is limited. Removing the barriers that shore protection structures create between coastal and upland habitats can reestablish exchanges of sediment and the ecological functions of the natural ecotone. The potential for removing these structures was evaluated in 12 national parks managed by the U.S. National Park Service. Criteria for removal included condition of structures, influence of natural processes, environmental benefits, public safety, and visitor access and use.

We found that 145 structures out of a total of 407 could be removed or allowed to deteriorate. We highlight three adaptation projects that are currently being conducted, two of which involve removing structures. Reasons for not taking a more pro-active approach to removing protection structures include (1) conflicting policy directives; (2) presence of key access roads and critical archaeological and historic sites; (3) lack of data; (4) lack of funds and human resources; (5) reluctance to replace known problems with an unknown set of problems; (6) consideration of visitor desires; and (7) reluctance to allow erosion to occur. Demonstration projects are needed to provide information about adaptation strategies that promote enhancement of ecosystem functions. Projects to remove protection structures are likely to be viewed as successful only if results are specified as a positive product, and the distinction between the concept of loss (erosion of existing landforms and habitats) and the concept of gain (evolution of new landforms and habitats) is made clear.

1. Introduction

Recognition of the value of nature and the services it provides to humans has increased in recent years (Luisetti et al., 2011) along with studies of human adaptation to climate change and sea level rise (Abel et al., 2011; Roca and Villares, 2012; Niven and Bardsley, 2013). The advantages of retreating from the coast to allow landforms and habitats to evolve have been acknowledged, but implementation of actual adaptation responses by moving landward is limited (Morris, 2012; Roca and Villares, 2012; Niven and Bardsley, 2013; Cooper and Pile, 2014), and retreat can be reactive rather than proactive (Ledoux et al., 2005).

Many scientists, managers and planners argue that fixed shore protection structures are detrimental to natural resources because they restrict movement of sediment and biota, truncate or eliminate beaches, dunes, bluffs and marshes and restrict future management options (Pilkey and Wright, 1988; Jolicoeur and O'Carroll, 2007; Defeo et al., 2009; Dugan et al., 2011). Greater dynamism allows landforms and habitats to undergo cycles of change that retain diversity and complexity and increase resilience (Doody, 2001; Larsen et al., 2007; Arens et al., 2013; Walker et al., 2013). Accordingly, emplacement of new protection structures has been restricted in several jurisdictions (Platt et al., 2002; Kelley, 2013), and some structures are being removed in others. Removal occurs mostly on low energy coasts to restore natural environments farther landward in managed realignment projects (French, 2006; Rupp-Armstrong and Nicholls, 2007) or less commonly to create beaches as recreational amenity and spawning sites (Zelo et al., 2000; Toft et al., 2013). Increases in sea level, intensity of storms and the potential for accelerated coastal erosion are expected in the future in many locations (FitzGerald et al., 2008; Boon, 2012; Stocker et al., 2013), placing increased emphasis on

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finding ways to adapt. Removing shore protection would permit sediment exchanges between beach and upland and help restore landforms and associated habitats.

This study is an evaluation of the potential for removing shore protection structures or allowing them to deteriorate to allow natural shoreline processes to prevail as part of an adaptation strategy for future sea level rise. The study was conducted in coastal parks managed by the U.S. National Park Service (NPS) in their Northeast Region (Fig. 1). The study includes (1) identifying all protection structures within the boundaries of the twelve parks; (2) determining the current function of each structure in protecting a cultural or natural resource; (3) identifying opportunities to facilitate migration of landforms and their associated habitats by removing or altering the structures; and (4) identifying structures that can be removed without threat to critical infrastructure. The results are discussed in terms of the policy framework, impediments to adapting by managed retreat, and tradeoffs between removing protection structures and allowing them to deteriorate.

2. Study sites and policy framework

The twelve coastal parks are located near or within urban and suburban lands. The parks have somewhat different missions and exhibit great variability in physical characteristics, cultural resources, levels of human development, modes and intensities of access, management focus, and interests of visitors and external stakeholders (Table 1). Four parks are totally within estuaries. The other parks have sizeable portions of their shorelines in estuaries or bays, but all sites differ in their degree of wave exposure. Maximum fetch distance for wave generation in the estuaries ranges from about 300 m to over 20 km. Six parks have portions of shoreline directly exposed to ocean waves. Erosion rates can be up to or greater than 2 m yr^{-1} in portions of Cape Cod, Fire Island, Gateway and Assateague Island (Hammar-Klose et al., 2003; Pendleton et al., 2004a,b, 2005). Relative rates of sea level rise monitored during the period 1854–1999 are 3.88 ± 0.15 mm yr^{-1} (based on 68 years of data) at Sandy Hook in Gateway (Pendleton et al., 2005), 2.65 ± 0.10 mm yr^{-1} (79 years of data) in Boston Harbor, near Cape Cod (Hammar-Klose et al., 2003), and at least 3.16 ± 0.16 mm yr^{-1} (81 years of data) and 2.58 ± 0.19 mm yr^{-1} (53 years of data) at stations near Assateague Island and Fire Island (Pendleton et al., 2004a,b).

Park resources protected in the past include cultural features (e.g. historic buildings, forts and bunkers, archaeological sites) and infrastructure (e.g. roads, visitor centers and other buildings, parking and picnic areas). Threats to resources vary in scale and importance, from erosion of earthen access paths and picnic areas that can be relocated with modest effort, to erosion of large scale water treatment facilities (Boston Harbor Islands and Gateway) and private homes adjacent to park boundaries. Levels of human development vary from isolated visitor facilities occupying only a small portion of a park to nearly complete conversion to a human-modified landscape in small parks in urban areas. Many past

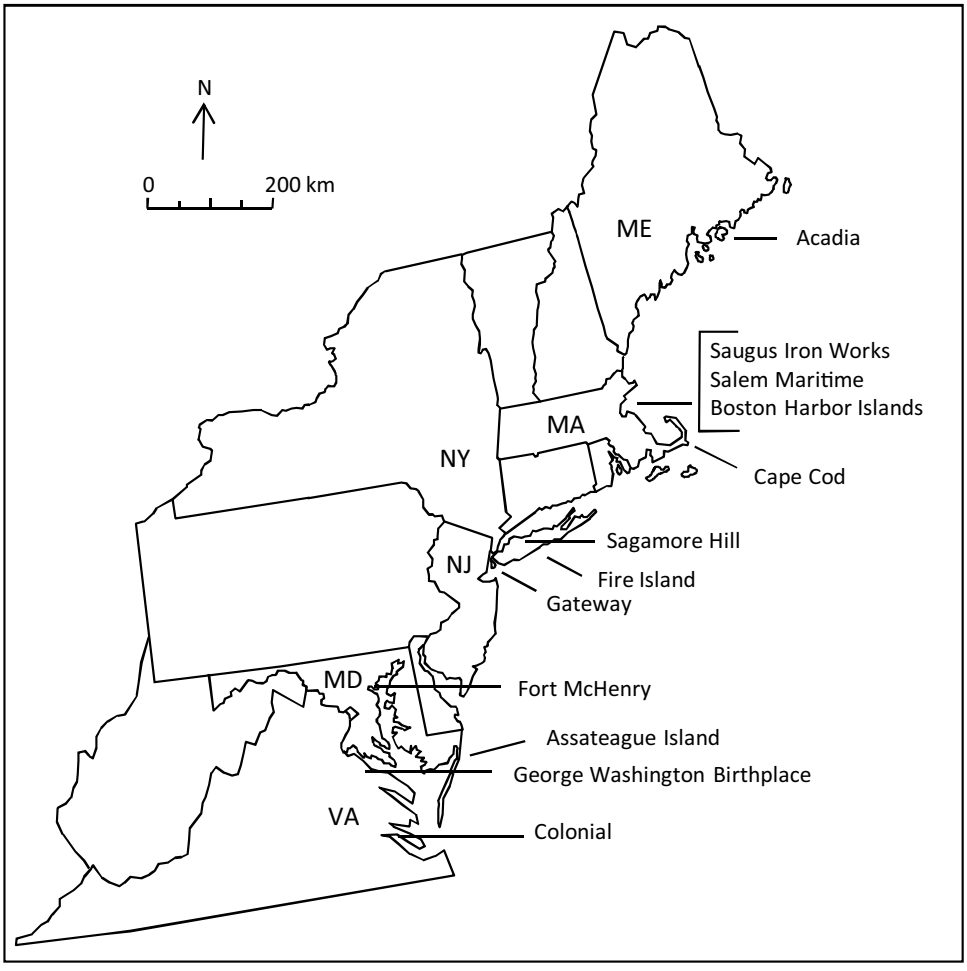

Fig. 1. Location of seashore parks in the Northeast Region of the National Park Service.

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