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Salt Marsh Dieback: An overview of recent events in the US

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ABSTRACT

This paper provides an overview of the marsh dieback events that have been observed along the east and gulf coasts of the U.S. over the past decade. It is likely that some of the recently reported changes in marsh vegetation were affected by physical or biotic disturbances that are known to generate bare areas, such as overgrazing or wrack smothering. Other areas may be experiencing a state change such as that caused by long-term changes in sea level. However, sites in many areas are not readily explained by these causes and are considered to have experienced "sudden dieback." In such cases, there are observations that the above-ground plant material thinned or browned or, in some cases, failed to re-emerge in the spring; the dieback occurred over a period of months and usually affected multiple sites within the area; and there is evidence that these events are transient (through successful transplants or natural regrowth/recovery), although some areas take years to recover. We explored the potential linkage of dieback with drought (as characterized by the Palmer Severity Drought Index), and found that there is evidence for an association in the southeast (GA and SC) and the Gulf (LA), but not in the mid-Atlantic (DE, VA) or northeast (ME, RI, CT). We also review the evidence for potential causes of sudden dieback, including changes in soil chemistry, fungal pathogens, top–down consumer controls, and multiple stressors. There is currently no single explanation that can be applied to recent dieback. We highlight the need for the development of improved diagnostics that will allow us to better classify dieback areas and provide evidence for (or against) potential causes.

1. Introduction

Over the past decade there have been an increasing number of reports of salt marsh "dieback" in the US. In 2000, Louisiana experienced a sudden and acute dieback event (termed "brown marsh") that affected over 100,000 ha of *Spartina alterniflora*-dominated salt marsh throughout the Mississippi River deltaic plain (Lindstedt and Swenson, 2006). Between May and October 2000, affected areas showed a progression from yellow to brown leaves to bare mud as *S. alterniflora* and, to a lesser extent, *Spartina patens*, died and decomposed, usually in interior portions of the marsh (Fig. 1). Other sympatric species (*Juncus roemerianus*, *Avicennia germinans*) were visually unaffected. A similar dieback phenomenon had been observed on a smaller scale in marshes along the Florida panhandle between 1990 and 1995. Carlson et al. (2001) reported that patches of *S. alterniflora* as large as 1 ha became chlorotic, wilted and died within a period of 1 month. In 2001, portions of the salt marshes of coastal Georgia also began experiencing sudden dieback (Ogburn and Alber, 2006). In this case dieback affected both *S. alterniflora* and *J. roemerianus* and was characterized by noticeably thinning vegetation that deteriorated to bare mud with rhizome stubble (Fig. 2). Rhizomes did not take up vital stain (Franklin and Palefsky, 2004), and they did not re-sprout in the greenhouse (M. Alber, pers. obs.). By 2002, dieback sites were reported throughout the Georgia coast and into South Carolina, as well as on eastern Long Island (R. Rozsa, pers. comm.). In New England, bare sites were reported in 2002–2003 in Cape Cod, Massachusetts, and sites from Maine to Connecticut have since been documented (Table 1, Fig. 3). *Spartina alterniflora*, *S. patens*, *Distichlis spicata*, and *J. gerardii* were all affected to varying degrees. A survey of 25 sites in Massachusetts conducted in summer 2006 found that 14 had bare areas where marsh plants would be expected to occur (Smith and Carullo, 2007). "Dieback" of *S. alterniflora* has now been reported in the mid-Atlantic (Delaware Inland Bays (Fig. 4), the Virginia Coast Reserve, and parts of the Chesapeake Marshlands Blackwater National Wildlife Refuge), and there have also been reports of dieback of hybrid *Spartina* (*S. alterniflora* × *Spartina foliosa*) in California (Neira et al., 2007). In 2007,

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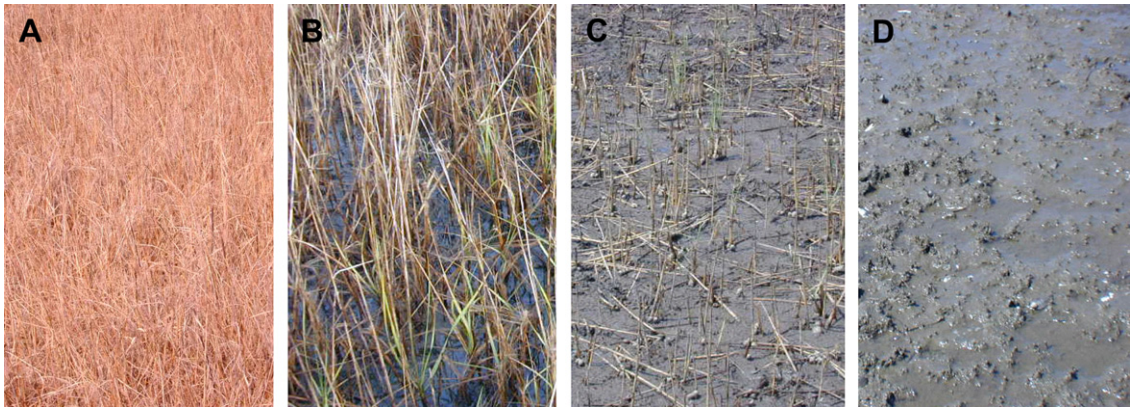

Fig. 1. Dieback in Louisiana: (A) standing dead S. *alterniflora* (June 2000); (B) initial thinning (Aug. 2000); (C) evidence of plant loss (Oct. 2000); (D) bare mud (April 2001). Photos (courtesy K. McKee) are representative of various aspects of dieback and are not necessarily taken at the same location.

Louisiana reported a new brown marsh event (but smaller in aerial extent than in 2000); new dieback areas were also observed in Georgia (Fig. 2a).

It is not clear that all of the above events were in fact actually dieback. Plant dieback, as the name implies, is a phenomenon that causes plants to undergo rapid senescence, resulting in mortality. Mueller-Dombois (1986) defines dieback in trees as "stands of dead or dying trees whose dieback cause is not obvious and that typically occur in several locations of a larger forest ecosystem." Dieback affects groups of neighboring trees and is often rapid: in cases of sudden oak death, the foliage turns brown within weeks, with tree death following over months to years (Rizzo and Garbelotto, 2003). Dieback has been reported for numerous plants in the botanical literature, ranging from seagrass die-off in Florida Bay (Fourqurean and Robblee, 1999) to sudden oak death in California (Rizzo and Garbelotto, 2003). The causes of dieback events are not always known, but both abiotic (e.g. temperature change) and biotic (e.g. fungal pathogens) mechanisms have been implicated in different cases. In this paper, we define sudden salt marsh dieback as a progressive decline that begins with thinning and browning of the above-ground material and leads to plant death over a period of months. Dieback areas are usually found simultaneously in several

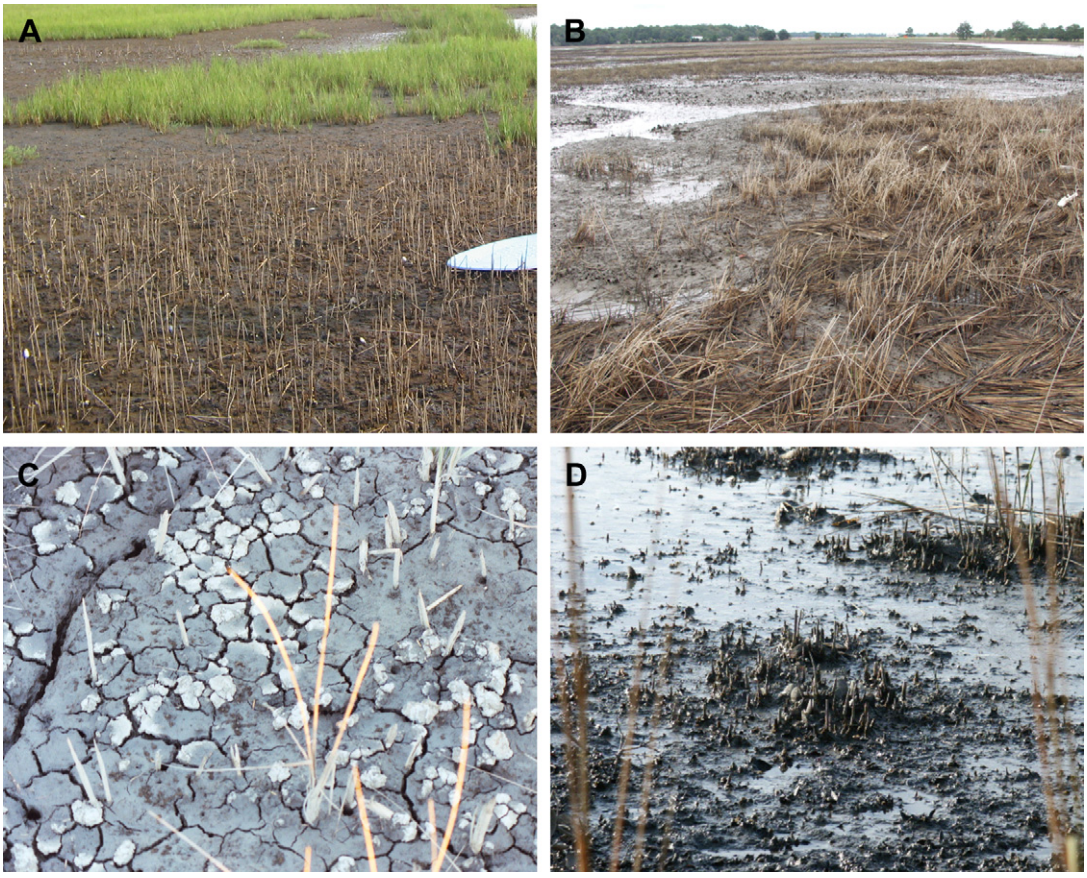

Fig. 2. Dieback in Georgia: (A) standing dead S. *alterniflora* (Aug. 2007); (B) standing dead *J. romerianus* (Oct. 2002); (C) evidence of desiccation (Dec. 2002); (D) rhizome stubble (February 2003). Photos (courtesy P. Baas, T.D. Bishop and J. MacKinnon) are representative of various aspects of dieback and are not necessarily taken at the same location.