



Nutrient levels modify saltmarsh responses to increased inundation in different soil types



Joanne X.W. Wong^{a, b}, Carl Van Colen^b, Laura Airoidi^{a, *}

^a Alma Mater Studiorum – Università di Bologna, Dipartimento di Scienze Biologiche, Geologiche ed Ambientali (BiGeA), Italy

^b Ghent University, Research Group of Marine Biology (MARBIOL), Belgium

ARTICLE INFO

Article history:

Received 26 September 2014

Received in revised form

22 December 2014

Accepted 24 December 2014

Available online 25 December 2014

Keywords:

Spartina maritima

Saltmarsh

Multiple stressors

Marsh organ

Inundation

Nutrients

ABSTRACT

Saltmarshes have been depleted historically, and cumulative stressors threaten their future persistence. We examined experimentally how nutrient availability (high vs. low) affects the responses of *Spartina maritima* to increased inundation in two mineral soil types (low vs. medium organic). Increased inundation, one of the effects of accelerated sea level rise, had negative effects on most plant growth parameters, but the magnitude varied with soil and nutrient levels, and between plants from different locations. Average differences between inundation treatments were largest at high nutrient conditions in low organic matter soils. We conclude that saltmarsh vegetation would be more drastically affected by increased inundation in low than in medium organic matter soils, and especially in estuaries already under high nutrient availability. This knowledge enhances the prediction of changes at the foreshore of saltmarshes related to sea level rise, and the development of site-specific conservation strategies.

© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

Many valuable coastal ecosystems have declined due to the cumulative effects of local and global anthropogenic stressors (Halpern et al. 2008; Ban et al., 2014; Strain et al. 2014), leading to loss of valuable ecosystem services and contributing to persistent poverty and risk (Millennium Ecosystem Assessment, 2005). Over the centuries, coastlines have been altered by land reclamation and development, overfishing, pollution and species invasions (Lotze et al. 2006; Airoidi and Beck, 2007). When coupled with climatic instabilities, localized human perturbations are creating new disturbance regimes which are further accelerating the degradation and decline of coastal ecosystems (Claudet and Fraschetti, 2010). With current delays and limitations on the mitigation of global stressors, it is crucial to identify which factors can maintain ecosystem resilience at local scales (Brown et al. 2013).

Saltmarshes are prime examples of a threatened coastal ecosystem that supports important ecosystem services including maintenance of water quality, provision of habitat, carbon sequestration and control of shoreline erosion (Zedler and Kercher,

2005; Ysebaert et al. 2011; Silliman et al. 2012). Saltmarshes globally have been in steady decline (Lotze et al. 2006), with reductions in Europe by more than 60% (Airoidi and Beck, 2007) and in the US by 50% (Kennish, 2001). Remaining tracts of intact saltmarshes are threatened by a variety of human-related stressors (e.g. Silliman and Bertness, 2004; Goldman Martone and Wasson, 2008; Uhrin and Schellinger, 2011; Lin and Mendelsohn, 2012) including two ubiquitous factors impacting coastal zones worldwide: excess nutrient input, a local scale stressor arising from intensive farming and inadequate wastewater treatment in the watershed, and relative sea level rise (RSLR) accelerated by climate change and amplified in some regions by land subsidence (FitzGerald et al. 2008; Deegan et al. 2012).

Relative sea level rise affects saltmarsh biogeochemistry through a variety of processes. As sea level rises relative to the existing saltmarsh elevation, inundation time of the saltmarsh platform increases. Increased inundation inhibits plant growth due to a combination of mechanisms, including reduced photosynthesis related to stomatal closure, root death due to anoxia, and reduced growth resulting from build-up of toxic compounds in the soil (e.g. hydrogen sulphide) under low redox and anaerobic conditions (DeLaune et al., 1987). In addition, reduced root biomass production hampers the ability of saltmarshes to grow vertically to keep up with RSLR (Morris et al. 2002; DeLaune and Pezeshki, 2003;

* Corresponding author. Università di Bologna, Dipartimento di Scienze Biologiche, Geologiche ed Ambientali BiGeA, Via S. Alberto 163, 48123 Ravenna, Italy.
E-mail address: laura.airoidi@unibo.it (L. Airoidi).

Table 1
Effects of higher nutrient availability on shoot and root biomass, R:S biomass ratio and soil, summarized from enrichment experiments and correlational studies. †: increase, ‡: decrease, ↔: no change, NR: not reported.* Trend estimated from reported data.

Reference	Species and study duration	Shoot biomass	Root biomass	R:S biomass ratio	Soil effects	Suggested mechanism
Valiela et al. (1976).	<i>S. alterniflora</i> & <i>S. patens</i> , 7 months	†	‡ at highest nutrient concentrations	‡*	NR	Some grasses stop producing more roots once N absorption is adequate.
Morris and Bradley (1999).	<i>S. alterniflora</i> , 12 years	‡	NR	NR	‡ soil C stores; † sediment accretion	Soil C loss from increased soil respiration; dense shoots trap more sediment.
Boyer et al. (2000).	<i>S. foliosa</i> , 2 years	NR	↔	NR	NR	Low N-retention in soil due to sandy substrate or poor conversion rate by microorganisms.
Wigand et al. (2004).	<i>S. patens</i> , 2.5 years	†	↔	‡	NR	Removal of N-limitation allows plants to shift energy to shoot growth, requiring additional P, which can be achieved via stimulation of endomycorrhizal colonization in existing roots, instead of increasing root density.
Tyler et al. (2007).	(a) Invasive hybrid <i>Spartina</i> (<i>S. foliosa</i> x <i>S. alterniflora</i>), San Francisco Bay, 5 months	†	↔	‡ at edge plots	NR	Root biomass in this eutrophic location likely not N-limited.
	(b) Invasive <i>S. alterniflora</i> , Willapa Bay, 5 months	†	† in meadow plots	‡ at edge plots	NR	Root biomass in this location is N-limited so N-addition led to increased root growth. However, shoot biomass increased proportionately more than root biomass.
Darby and Turner (2008b).	<i>S. alterniflora</i> , 5 months	†	↔ when only N added; ‡ when N + P added	‡ when either N or P added	‡ in soil redox potential	N-addition stimulated shoot biomass only; root foraging relaxed when P-availability increased.
Turner et al. (2009).	<i>S. alterniflora</i> , <i>S. patens</i> , <i>Distichlis spicata</i> mixed marsh, 36 years	†	NR	‡	↔ in soil accumulation rate; organic matter accumulation ‡ in deep soil layer but ↔ in upper layer; ‡ shear vane strength	Increase in carbon loss via denitrification and other coupled processes between C metabolism and N cycle.
Wigand et al. (2009).	<i>S. alterniflora</i> , <i>S. patens</i> (correlation data)	NR	‡ for <i>S. patens</i>	NR	† in soil respiration rate for both species	Increased turnover of labile C and N in upper layer of <i>S. alterniflora</i> marsh.
Anisfield and Hill (2011)	<i>S. alterniflora</i> , 5 years	†	↔	‡*	↔ in soil C; ↔ in elevation; slight † in accretion in N + P fertilized plots	Loss of soil C in high nutrient treatment is offset by other processes, e.g. increased gross root production and respiration, leading to no change in belowground primary production.
Nelson and Zavaleta (2012).	<i>Sarcocornia pacifica</i> , <i>Jaumea carnosa</i> , <i>Frankenia salina</i> , and <i>D. spicata</i> (perennial), 2 years	†	†	‡*	NR	Shoot biomass increase was much larger than root biomass increase; capacity to absorb N remains even in "hypertrophic" environment.
Deegan et al. (2012).	<i>S. alterniflora</i> and <i>S. patens</i> , 9 years	†	‡	‡	‡ soil and creek bank stability; conversion of marsh to open water	Faster decomposition of N-rich leaf detritus; increased denitrification and soil

Download English Version:

<https://daneshyari.com/en/article/4550713>

Download Persian Version:

<https://daneshyari.com/article/4550713>

[Daneshyari.com](https://daneshyari.com)