

Biological top-down control of tidal marshes can regulate time-scales for establishment and recovery

Jim van Belzen^{1,2}, Christian Schwarz^{1,2,3}, Stijn Temmerman^{1,2,3}, Oliver Gorge^{1,2,3}, Tjeerd Bouma^{1,2} and Johan van de Koppel^{1,2}

¹ Royal Netherlands Institute for Sea Research (NIOZ), Department of Estuarine and Delta Systems, PO Box 59, 1790 AB Den Burg, Texel, The Netherlands
E-mail: jim.van.belzen@nioz.nl

² Utrecht University, PO Box 140, 4400 CA Yerseke, The Netherlands

³ University of Antwerp, Ecosystem Management Research Group, Wilrijk, Belgium

A major knowledge gap in restoration of tidal marshes (e.g. by managed re-alignment) consists in the high variance in time-scales needed for their re-establishment after which restoration can be regarded successful. Often only physical factors (e.g. intertidal elevation and wave action) are considered to provide the conditions for re-establishment of tidal vegetation, however there are strong indications that biotic interactions can also play a pivotal role explaining variance in rates of establishment success.

In this study, we tested the potential of top-down control by animals (i.e. benthic macrofauna and birds) to explain the slow colonization of a de-embanked area (i.e. 'Paardenschor') along the Scheldt estuary (Belgium) by a combination of field and laboratory experiments. This site is sheltered from waves and has a relatively high elevation (1-5% of time inundated) at which old established marshes are growing, yet revegetation is slow.

Results from a seedling survival experiment in the field reveal that macrofauna benthos, and more specifically the ragworm *Hediste diversicolor*, had a significant effect on the survival of transplanted *Aster tripolium* seedlings in the field, while the influence of birds was less obvious. Additional laboratory experiments show that seedlings are able to escape from grazing when they are growing within patches of the macroalgae *Vaucheria* sp. Furthermore, although birds did not affect the survival of seedlings in our field experiment we present additional observations and results that suggest that birds are possibly still important affecting the tidal flat development and vegetation establishment early in the growing season due to bioturbation.

Although further research into the role of birds and benthos is needed, our results underline that biological interactions (i.e. consumption and habitat modification) can be an important top-down control delaying establishment of tidal marsh vegetation and should therefore be accounted for when predicting the success of tidal-marsh restoration.