Mechanistic modelling of *Phragmites australis* in tidal marshes

Evaluation of the effect of clonal growth forms at varying habitat quality

Jana Gevers [1], Boris Schröder [1, 2]

[1] University of Potsdam, Institute of Earth and Environmental Sciences, Potsdam, Germany; [2] Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany

Figure 1
Study site: the tidal passage of the river Elbe

1 Background

A better understanding of the response of reed (*Phragmites australis*) to changes in the hydrodynamic tidal-regime is essential as it provides important ecosystem functions and services in the tidal passage of the river Elbe (Figure 1).

General questions

- How does marsh vegetation develop with global warming-induced changes in process dynamics?
- What are the abiotic and biotic drivers of vegetation zoning in tidal marshes?
- What is the relationship between habitat variability, ramet growth and stable patterns of the distribution of tidal marsh species?

2 Methods

Mechanistic, pattern-oriented modelling based on the study of Wortmann et al. (1998)[1] (Figure 2)

- Landscape model: low and high quality habitat cells in differing amounts and with random configuration
- Reed model: density and habitat dependent growth and mortality of rhizomes, roots and above ground biomass; dispersal is implemented by rhizome expansion into neighbouring cells
- Linkage via response functions for each habitat factor
- Introduction of clonal integration[2] (support of ramets by neighbouring ramets) & foraging[3] (ability of clonal plants to adapt their growth on local habitat conditions)

First steps

- Evaluation of the effect of the two forms of clonal growth by comparing results at different habitat qualities (Figure 3, 4)
- Aboveground biomass: decreases linear with declining habitat quality until 60% of low-quality habitat without clonal growth forms (threshold) (Figure 4).

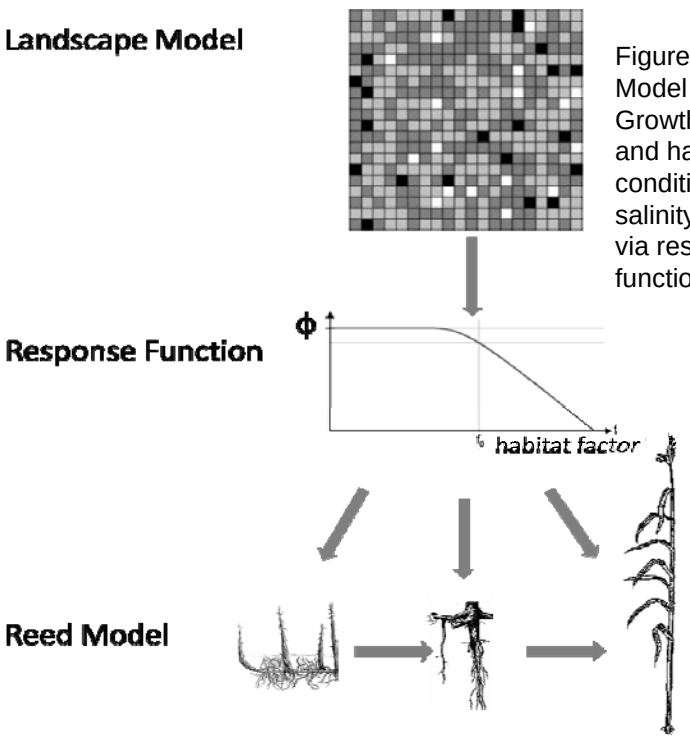

Figure 2
Model structure: Growth model and habitat conditions (e.g. salinity) linked via response functions

3 First Results

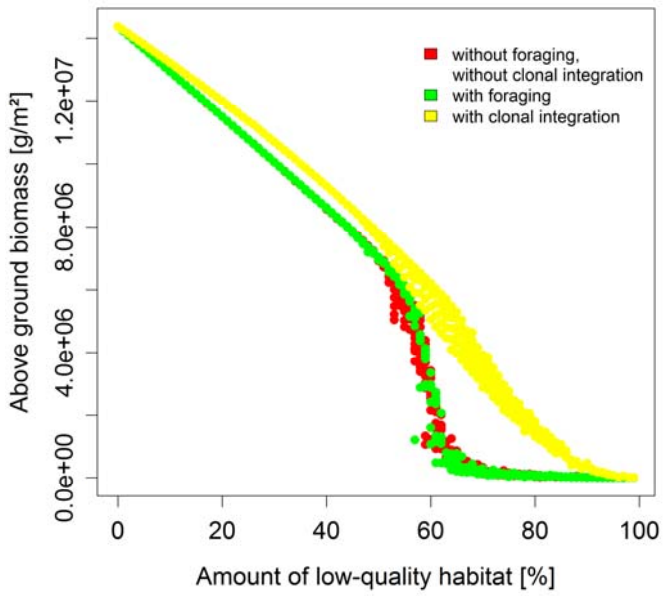

Figure 4
Above ground biomass at different habitat qualities

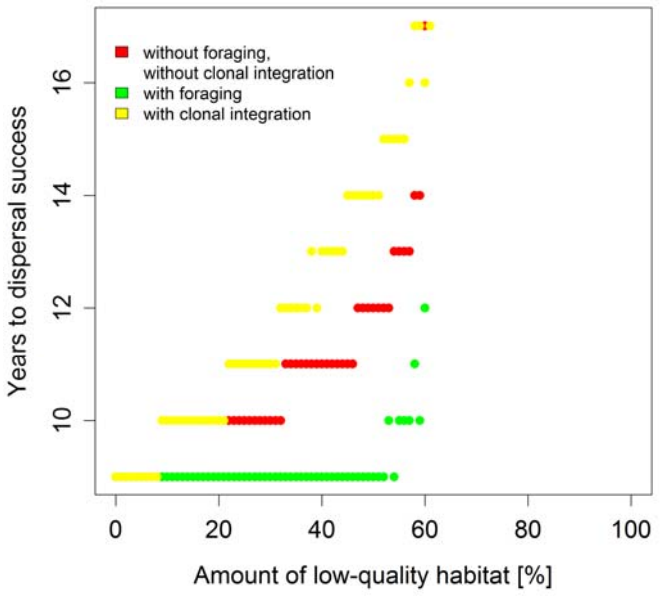

Figure 5
Years untill dispersal success (time to reach the other end of the habitat) at different habitat qualities

- Clonal integration positively effects the aboveground biomass by the compensation of heterogenic growth conditions.
- The speed of dispersal decreases with declining habitat quality until 60% low-quality habitat without clonal growth forms (no dispersal success) (Figure 5).
- Foraging positively effects the speed of colonization by directional dispersal.

4 Outlook

- Developing a landscape model from field data
- Establishing the response and effect functions to link the reed growth model with the landscape model
- Parameterisation with field data
- Model validation with the help of historical vegetation maps

References:
[1] Wortmann J, Hearne JW, Adams JB (1998) Evaluating the effects of freshwater inflow on the distribution of estuarine macrophytes, Ecological Modelling, 106, 213–232.
[2] Amsberry, L., M. A. Baker, et al. (2000). Clonal integration and the expansion of *Phragmites australis*. Ecological Applications 10(4): 1110-1118.
[3] De Kroon, H. and M. J. Hutchings (1995). Morphological plasticity in clonal plants: the foraging concept reconsidered. Journal of Ecology 83(1): 143-152.

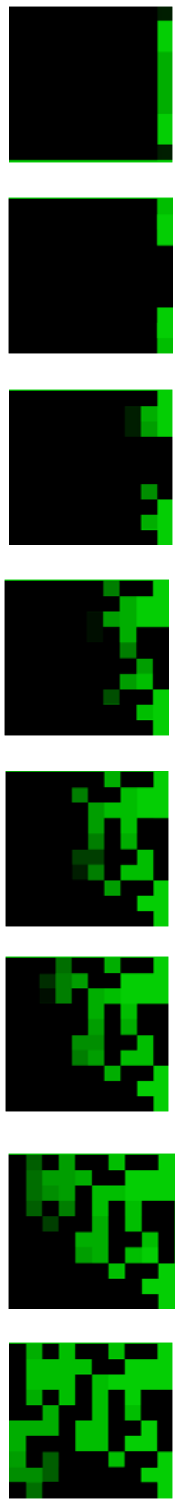

Figure 3
Reed dispersal in the model (low quality habitat: 50%)

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- National Meteorological Service in Germany (DWD)
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- ***www.kliwas.de***

Jana Gevers

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Universität Potsdam
Karl-Liebknecht-Str. 24-25
14476 Potsdam

Tel.: +49 (0)331/9772518
E-mail: jgevers@uni-potsdam.de

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