Fragmentation and plant dispersal capacity in Dutch wetlands

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Introduction

Wetlands fulfil important ecological functions as regulators of worldwide water regimes and carbon-, and oxygen cycles (Best *et al*., 1993) and there biodiversity is often large (Mitsch and Gosselink, 1993). In the Netherlands, plant diversity is especially large in the groundwater dependent, nutrient poor floating fens, belonging to the community of *Caricion davallianae* (Best *et al*., 1993). However, wetlands are declining rapidly worldwide (Finlayson and Moser, 1991), and only 80 hectare floating fen is left in the Netherlands (Beltman *et al.,* 2001).
Many studies investigated the causes of deterioration of these low productive fens (e.g. Barendregt *et al*., 1995; Bootsma and Wassen, 1996). However, most studies only considered abiotic processes, ignoring the importance of seed dispersal for plant occurrence. In fragmented habitats, such as the Dutch wetlands, dispersal capacity can become limiting, resulting in a decreasing connectivity of the remaining subpopulations and thereby affecting the persistence of plant species (Hanski and Gyllenberg, 1993).
We hypothesise that habitat fragmentation has negative effects on floating fen plant viability, in addition to changes in site factors. To gain more insight in both the effect of abiotic factors and of habitat fragmentation on floating fen species occurrence, several datasets comprising data on site factors, plant species composition and spatial configuration of plant populations in the Dutch Vecht river plain were subjected to a logistic regression analysis.
To gain more insight in seed dispersal and colonization capacity of the considered fen plant species in a fragmented area, several field experiments were carried out. As soil moisture is strongly positively related to the percentage of hydrochorous species (Ozinga et al. 2004), it is expected that dispersal by water plays an important role in the wet fen ecosystems. Therefore, focus in this study is on hydrochory.

Methodology

Logistic regression analysis

To gain insight to the key-factors that determine plant presence, a forward stepwise logistic regression analyses was performed with abiotic variables and variables related to fragmentation as independent factors and presence/absence of plant species as dependent factor.
Abiotic variables considered in the analysis were Electro-Conductivity (EC25) pH, groundwater table, soil temperature, nutrients (K^+, NO_3^-, NH_4^+, $H_2PO_4^-$, P_{tot}) and ions (Ca^{2+}, Mg^{2+}, Na^+, Cl^-, HCO_3^-, SO_4^{2-}, Fe_{tot}, Al_{tot}, Mn_{tot}, S^{2-}, SiO_2, Cu_{tot}, Pb_{tot} and Zn^{2+}) in the groundwater samples. Both the first order and second order polynomials were candidate predictors.
Patch area and perimeter, number of populations within 500 metres, distance to the neighbouring hill ridge and height are variables related to habitat fragmentation or spatial configuration that were used as independent variables in the analysis.

For the present study, two floating fen species (*Carex diandra* and *Menyanthes trifoliata*) and one fen meadow species (*Lychnis flos-cuculi)* were selected.

Seed dispersal experiments

To assess the dispersal and colonization capacity of the considered fens species, painted seeds were released on fens and in water bodies, and recaptured with nets in the water and astroturf mats on the banks. Results of these experiments are not available yet, as the study is ongoing.

Results

Logistic regression analysis

Preliminary results show a highly significant positive relation between the number of populations within 500 meters of each sampling point and the probability of occurrence of *C. diandra* and *M. trifoliata.* Furthermore, highly significant positive (*C. diandra* and *M. trifoliata*) and optimum (*L. flos-cuculi*) relations between plant occurrence and Ca^{2+} content were found. Other significant predictors for plant occurrence were the area of the suitable habitat (*L. flos-cuculi*, positive relation), temperature (*M. trifoliata*, positive relation) water table (*C. diandra* and *M. trifoliata*, optimum relation), Cl^- content (*L. flos-cuculi*, positive relation) and Al_{tot} content (*L. flos-cuculi*, negative relation).

Discussion

The fact that the number of populations within 500 meters of a location (*C. diandra* and *M. trifoliata*), and the size of the habitat patch (*L. flos-cuculi*) are positively related to the occurrence of the species is in line with metapopulation theory (Hanski and Gyllenberg, 1993) and indicates the negative effect of fragmentation on plant species viability. The positive relation of occurrence of all three species with Ca^{2+} content indicates the dependency of the species to discharge of calcareous groundwater. This endorses the efforts of nature managers to restore the original groundwater flow with seepage water discharging near the hill ridge.

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