Colonization by ecosystem engineers

Influence of trophic level and waterbird disturbance

Jeroen van Zuidam, Merel Soons and Jos Verhoeven
Ecology and Biodiversity Group
Utrecht University, the Netherlands
Peat formation starts with terrestrialization, which may not always be easy......
Questions....

- Which species are needed for colonization of open water?
- Which species function as ecosystem engineers?
- Do plant interactions (competition/facilitation) limit or enhance expansion?
- How does nutrient state influence the rate of colonization?
- Is disturbance by waterbirds relevant in the Volgermeer polder?
Colonization of open water and trophic level
Introduction

• Stimulating fast colonization
  Expansion from spatially distributed, artificial floating mats?

• Desired species characteristics
  – Vegetative spread – floating rhizomes
  – Productivity - buildup organic matter
  – Prefered trophic conditions for optimal performance

• Use functional plant groups
Functional groups and combinations

- **Clonal dominants (Cd)**
  - *Typha latifolia*
  - *Phragmites australis*
  - *Phalaris arundinacea*

- **Clonal stress tolerators (Cst)**
  - *Calla palustris*
  - *Potentilla palustris*
  - *Menyanthes trifoliata*

- **Interstitials (Is)**
  - *Alisma plantago aquatica*
  - *Iris pseudacorus*
  - *Acorus calamus*

**Combination 3FG**

- **Monoculture**

**Combination 2FG**

- **Combination 3FG**

24 plants per mat, evenly distributed
Experimental ponds NIOO, Loenen a/d Vecht

- 36 ponds, made with pond liner (5x5m), 70cm water
- 4 mats per pond
- 9 nutrient loadings, weekly additions
- All combinations at all nutrient loadings → dose-response relation
- Duration: 2 years

<table>
<thead>
<tr>
<th>Nr.</th>
<th>mg N/l</th>
<th>ug P/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0,15</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>0,3</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>0,6</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>0,9</td>
<td>90</td>
</tr>
<tr>
<td>5</td>
<td>1,2</td>
<td>120</td>
</tr>
<tr>
<td>6</td>
<td>1,5</td>
<td>150</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>300</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>500</td>
</tr>
</tbody>
</table>
Collected data

- Measurements:
  - Coverages on mat
  - Total rhizome length in water (peak growing season 2013 & 2014)
  - Dry weights of green biomass on mat
  - Dry weight of total biomass in water (sept 2014)

- Data corrected for number of planted individuals per functional group

- Lineair Mixed Modelling
  Comparison per functional group: differences between combinations and the effect of nutrient levels
Clonal dominants – on the mat

- Comparable, positive response to nutrients in all combinations
- Lowest coverages in monoculture
- Higher coverages when two other functional groups are present
Clonal dominants – rhizome formation

- Little rhizome formation – high variation in data
- Only a positive response to more nutrients in combination with two other functional groups in second year
- More rhizome formation when plants on mat perform better → in combination with all three functional groups
Clonal stress tolerators – on the mat

- Significant, positive response to nutrients in year 2
- No clear difference between combinations
Clonal stress tolerators – rhizome formation

- Highly productive
- Positive response to nutrients, strongest in year 2
- No clear differences between combinations
Interstitials – on the mat

- Positive response to nutrients in both years, strongest in year 2
- Interstitials develop higher coverages in combination with other two functional groups
Conclusions

**Clonal dominants** (*Typha latifolia, Phragmites australis, Phalaris arundinacea*)

- Poorest performance
- Positive response to nutrients, rhizome formation is limited
- Development is best when other two functional groups are present → facilitation needed?

**Clonal stress tolerators** (*Calla palustris, Potentilla palustris, Menyanthes trifoliata*)

- Strong positive response to nutrients
- Combinations not important
- Produced largest amount of rhizomes in all combinations → strong ecosystem engineer!
Conclusions

**Interstitials** (*Alisma plantago aquatica, Iris pseudacorus, Acorus calamus*)

- Strong positive response to nutrients $\rightarrow$ **organic matter production**
- Perform best in combination with two other groups $\rightarrow$ **facilitation**?
- No colonization of floating rhizomes

**Implications for terrestrialization**

- Artificial floating mats seem suitable
- Clonal stress tolerators important ecosystem engineers, Interstitials contribute to organic matter
- Diversity seems important (facilitation?)
- Eutrophic conditions: faster rhizomal spread, competition not (yet) important
Influence of waterbird disturbance
Experimental setup

• Similar mats and measurements as used for colonization experiment

• In Volgermeer; 3 basins containing organic sediment and water from storage reservoirs

• 3 protection levels:
  – no protection (0)
  – only the vegetation on the mat (1)
  – vegetation on the mat and in the water (2)

• All 7 combinations in all 3 protection levels, 3 basins as replicates

• Data from July 2014 presented
Most disturbance caused by Eurasian coot (*Fulica atra*)
Differences between treatments per functional group

• Per functional group no differences between combinations → no clear interaction effects

• Between treatments per functional group:
Differences between functional groups within each protection level

Coverage on the mat and biomass:

• Unprotected: coverage and biomass of Interstitials higher than in other two groups

• Both levels of protection: Increased coverages of Clonal dominants and Clonal stress tolerators → all three groups comparable coverages

Biomass:

Clonal stress tolerators = Interstitials.  
Clonal dominants <

Rhizome formation:

• Clonal stress tolerators always produce largest amount of rhizomes

• Clonal dominants: hardly any rhizomes when unprotected (comparable to Interstitials = 0)  
Protection results in a significant increase
Conclusions

• Disturbance by waterbirds: negative effect on plant development (mat & rhizomes)

• Protecting clonal plants (both groups) has positive effect

• Clonal stress tolerators again most important for colonization

• Poor performance Clonal dominants → more eutrophic conditions needed?

• Interstitials are tolerant → long term competitive exclusion?!
And the winners are....

But be aware!
Thanks to Liesbeth Bakker and NIOO for the use of the experimental ponds in Loenen!

Thanks to all the students and family for their help during fieldwork