Seed germination from deposited sediments during high winter flow in riparian areas

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River re-meandering and wetland restoration – DK in the forefront – but for nitrogen retention purposes – what about P-retention and biodiversity of restored wetlands?

Danish Governmental Decision: Second Action Plan on the Aquatic Environment

River Skjern
2200 hectares 34 mill. Euro

Lake Bølling
Area: 375 ha + 375 ha meadow

3000 ha lakes and 4000 ha wetlands restored from 1998-2006
Aim of this study: To determine the amount and pattern of seed deposition in restored riparian areas after high flow events.

Hypotheses:

1) Abundance of seeds increases with fine inorganic particles and organic matter content in deposited sediment.

2) Larger seeds primarily deposit close to the river – in the hydraulically active buffer zone.
Collection of sediment after winter high flow – triplicates of 50x50 cm grass mats (astroturf)

Spread sediment in trays in greenhouse

Distance from stream (m)

0 2 16 23 41 70 101

+0.16 m +0.32 m
Sediment deposition on an inundated floodplain transect during five winter periods
Fine sediment deposited on the floodplain during winter 2006/2007 – being the wettest winter ever recorded in Denmark (possibly a 200 years return flood).
### Deposited sediment characteristics

<table>
<thead>
<tr>
<th>Distance from stream (m)</th>
<th>2</th>
<th>16</th>
<th>23</th>
<th>41</th>
<th>70</th>
<th>101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment (kg DW m^-2)</td>
<td>9.36</td>
<td>15.25</td>
<td>7.80</td>
<td>1.22</td>
<td>1.28</td>
<td>0.73</td>
</tr>
<tr>
<td>Organic matter content (%)</td>
<td>1.8</td>
<td>21.9</td>
<td>27.3</td>
<td>35.4</td>
<td>43.4</td>
<td>52.8</td>
</tr>
<tr>
<td>Total P (mg P g^-1 DW^-1)</td>
<td>0.30</td>
<td>2.15</td>
<td>2.60</td>
<td>3.29</td>
<td>4.95</td>
<td>2.91</td>
</tr>
<tr>
<td>Total C (mg C g^-1 DW^-1)</td>
<td>8.47</td>
<td>96.1</td>
<td>109.9</td>
<td>135.5</td>
<td>142.7</td>
<td>176.2</td>
</tr>
<tr>
<td>Total N (mg N g^-1 DW^-1)</td>
<td>0.57</td>
<td>8.38</td>
<td>10.7</td>
<td>14.6</td>
<td>16.8</td>
<td>23.1</td>
</tr>
<tr>
<td>C/N ratio</td>
<td>17.2</td>
<td>13.4</td>
<td>12.0</td>
<td>10.8</td>
<td>9.9</td>
<td>8.9</td>
</tr>
<tr>
<td>Clay + silt content (%)</td>
<td>19</td>
<td>85</td>
<td>95</td>
<td>89</td>
<td>89</td>
<td>77</td>
</tr>
</tbody>
</table>

#### Particle sizes (% of deposited sediment)

- > 500 µm
- 250 µm
- 125 µm
- 63 µm
- < 63 µm

**Distance from river (m)**

- 0
- 20
- 40
- 60
- 80
- 100
Seedling emergence

- In total 897 seedlings emerged
- Distributed over 31 species
- Most frequent:
  - *Juncus bufonius* (n=468): common name: Toad Rush
  - *Juncus effusus* (n=262): common name: Common Rush.
  - *Urtica dioica* (n= 41): common name: Stingling Nettle
  - *Poa annua* (n= 36): common name: Annual Blue Grass
The four most frequent species

- *Juncus bufonius*
- *Juncus effusus*
- *Urtica dioica*
- *Poa annua*
Temporal dynamics of seedling emergence
Seedling characteristics with distance from river channel

<table>
<thead>
<tr>
<th>Distance from stream (m)</th>
<th>Number of seedlings (m$^{-2}$)</th>
<th>Species richness</th>
<th>Mean seed weight (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1367 ±1198$^a$</td>
<td>6.7 ±3.1$^b$</td>
<td>0.064 ±0.023$^a$</td>
</tr>
<tr>
<td>16</td>
<td>1183 ±176$^a$</td>
<td>10.7 ±1.5$^c$</td>
<td>0.041 ±0.010$^a$</td>
</tr>
<tr>
<td>23</td>
<td>3817 ±3595$^a$</td>
<td>4.0 ±2.0$^{ab}$</td>
<td>0.018 ±0.002$^a$</td>
</tr>
<tr>
<td>41</td>
<td>1050 ±467$^a$</td>
<td>3.0 ±1.0$^a$</td>
<td>0.031 ±0.013$^a$</td>
</tr>
<tr>
<td>70</td>
<td>1175 ±992$^a$</td>
<td>4.7 ±1.5$^{ab}$</td>
<td>0.058 ±0.035$^a$</td>
</tr>
<tr>
<td>101</td>
<td>2067 ±651$^a$</td>
<td>4.7 ±1.2$^{ab}$</td>
<td>0.043 ±0.013$^a$</td>
</tr>
</tbody>
</table>

No significant difference in seed weight or number of seedlings with distance!
Correlation between sediment characteristics, position in the riparian area and seedling characteristics

<table>
<thead>
<tr>
<th></th>
<th>Org. matter (fine particles and distance from stream)</th>
<th>Tot-P</th>
<th>Topography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of seedlings</td>
<td>0.512*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species richness</td>
<td></td>
<td>-0.497*</td>
<td></td>
</tr>
<tr>
<td>NMS scores, axis 1</td>
<td>-0.699**</td>
<td>-0.530*</td>
<td></td>
</tr>
<tr>
<td>NMS scores, axis 2</td>
<td>0.806***</td>
<td>0.693**</td>
<td>0.624**</td>
</tr>
</tbody>
</table>
Conclusions of this study:

1) Winter flooding of riparian wetlands causes deposition of viable diaspores
2) High variability on a small spatial scale
3) Abundance of seeds increases with fine inorganic particles and organic matter content in deposited sediment – strong linkages to micro topography of bufferzone and floodplain
4) No correlation between seed size and deposition distance
5) Only common eutrophied species dispersed – no rare species
6) Most seedlings emerge after 3 weeks
Management implications

Rehabilitating natural dynamic hydrological conditions between streams and wetlands assists in seed dispersal from upstream.

However, natural non-eutrophied communities most often not established due to missing colonization areas upstream?

May add seeds to rehabilitate wetland biodiversity.