Nutrient issues and recruitment limitation in flood-meadow restoration

Norbert Hölzel
Study region: northern Upper Rhine
Study area

Fossil floodplain

Functional floodplain
Water level dynamics in the functional and fossil floodplain of the northern Upper Rhine
(1980-1999)

Functional floodplain: Rhine-Gauge Nierstein-Oppenheim
Fossil floodplain: Groundwater gauge 500m beside the main channel

Source: Bundesanstalt für Gewässerkunde 2005, Hessische Landesanstalt für Umwelt 2005
Development of flood meadow area in the fossil floodplain (1925-2000)

Sources: Heyl 1929, Böger 1991, Krug 1997
**Restoration success in different floodplain compartments**

(n = 21 per category)

<table>
<thead>
<tr>
<th></th>
<th>Functional floodplain</th>
<th>Fossil floodplain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alt</td>
<td>Neu</td>
</tr>
<tr>
<td>$\alpha$-Diversity</td>
<td>26,9</td>
<td>20,4</td>
</tr>
<tr>
<td>$\gamma$-Diversity</td>
<td>102</td>
<td>80</td>
</tr>
<tr>
<td>Target species (cum. Freq.)</td>
<td>137</td>
<td>16</td>
</tr>
</tbody>
</table>

Eutrophication

Nutrient-enrichment by:

• polluted river water and sediments
• agricultural fertilizer residues
Eutrophication by polluted river water

Klaus VH, Sintermann J, Kleinebecker T & Hölzel N (submitted): Sedimentation induced eutrophication in large river floodplains - an obstacle to restoration?
DCA-diagramm with overlay of environmental variables

Klaus VH, Sintermann J, Kleinebecker T & Hölzel N (submitted): Sedimentation induced eutrophication in large river floodplains - an obstacle to restoration?
Soil P-concentrations along the cross section

Klaus VH, Sintermann J, Kleinebecker T & Hözel N (submitted): Sedimentation induced eutrophication in large river floodplains - an obstacle to restoration?
Soil P-concentrations and species-richness

Klaus VH, Sintermann J, Kleinebecker T & Hözel N (submitted): Sedimentation induced eutrophication in large river floodplains - an obstacle to restoration?
Hölzel, N. et al. (subm.): Assessment of trophic gradients in herbaceous plant communities by nutrient concentrations in aboveground biomass.
Hölzel, N. et al. (subm.): Assessment of trophic gradients in herbaceous plant communities by nutrient concentrations in aboveground biomass.
Hölzel, N. et al. (subm.): Assessment of trophic gradients in herbaceous plant communities by nutrient concentrations in aboveground biomass.
Topsoil removal
Eutrophication:

• strong eutrophication by P-enriched sediments is confined to the proximity of river channels (< 300 m)

• rapid depletion of plant-available N-pool in restored flood-meadows on former arable fields

• raised P-levels even after longterm removal of nutrients by haymaking

• rapid reduction of raised P-levels only by topsoil removal

• role of raised P-levels under N-limitation requires further clarification
Recruitment limitation

- depleted soil seed banks
- lack of source populations
- limited dispersal
Mass development of *Cerastium dubium* from the soil seed bank after reintroduction of mowing to a flood-meadow invaded by reeds
Seed bank persistence in flood-meadow species

Dispersal distance of target-species (ca. 10 years)

Source stand (species-rich *Cnidion*-meadow)
Harvesting of species-rich source stands
Transfer of seed-containing plant material
Restoration site in 1997
Same site 7 years after hay-transfer
Development of different species groups after transfer of seed-containing plant material

n = 80 plots

Transferred target species

Gentiana pneumonanthe

Arabis nemorensis

Viola elatior

Iris spuria
Recruitment limitation:

- seed and dispersal limitation are nowadays a major constraint to the restoration of species-rich flood-meadows

- contribution of persistent soil seed banks is confined to a limited number of species and favourable marginal conditions

- establishment success is even in close proximity to viable source population mostly very slow and inefficient

- hay transfer proved to be an extremely successful method to overcome seed and dispersal limitation

- for successful recruitment from hay open soil and low levels of competition are a prerequisite
Thanks to:
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Annette Otte  Jupp Scholz-vom Hofe  Jörg Sintermann

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WWW.UNI-GIESSEN.DE/STROMTALWIESEN
Veränderung der Deckungsgradsummen verschiedener Artengruppen nach Mahdgutauftrag auf einer Renaturierungsfläche

$n = 80$ plots