Dispersal versus environmental filtering along riparian moisture gradients

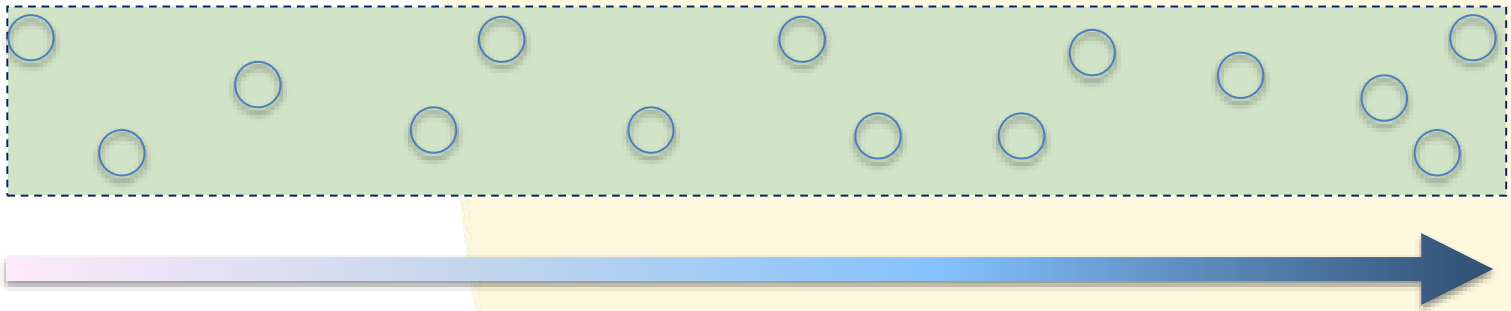
Rob Fraaije
Utrecht University
Ecology and Biodiversity Group

G.P. Verduyn, C.J.F. ter Braak, J.T.A. Verhoeven, M.B. Soons

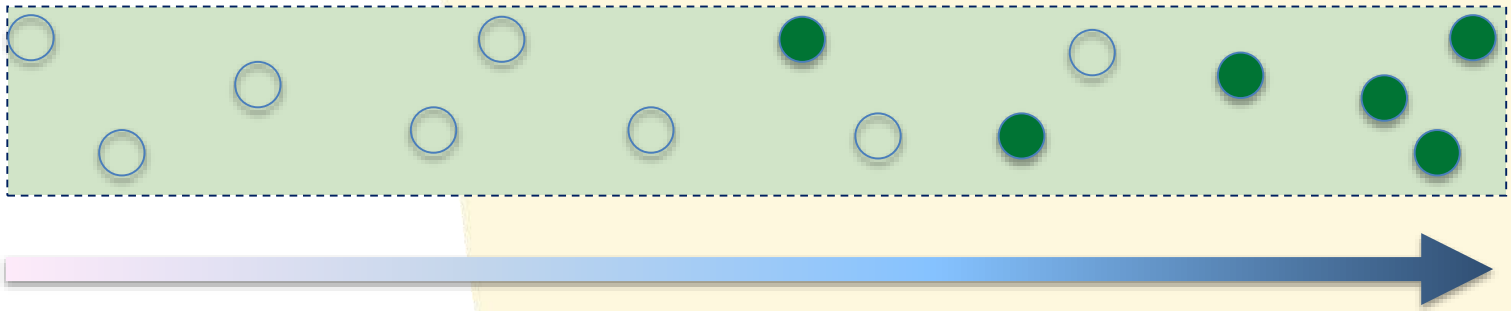
30 August 2016

Universiteit Utrecht

Environmental / dispersal filtering

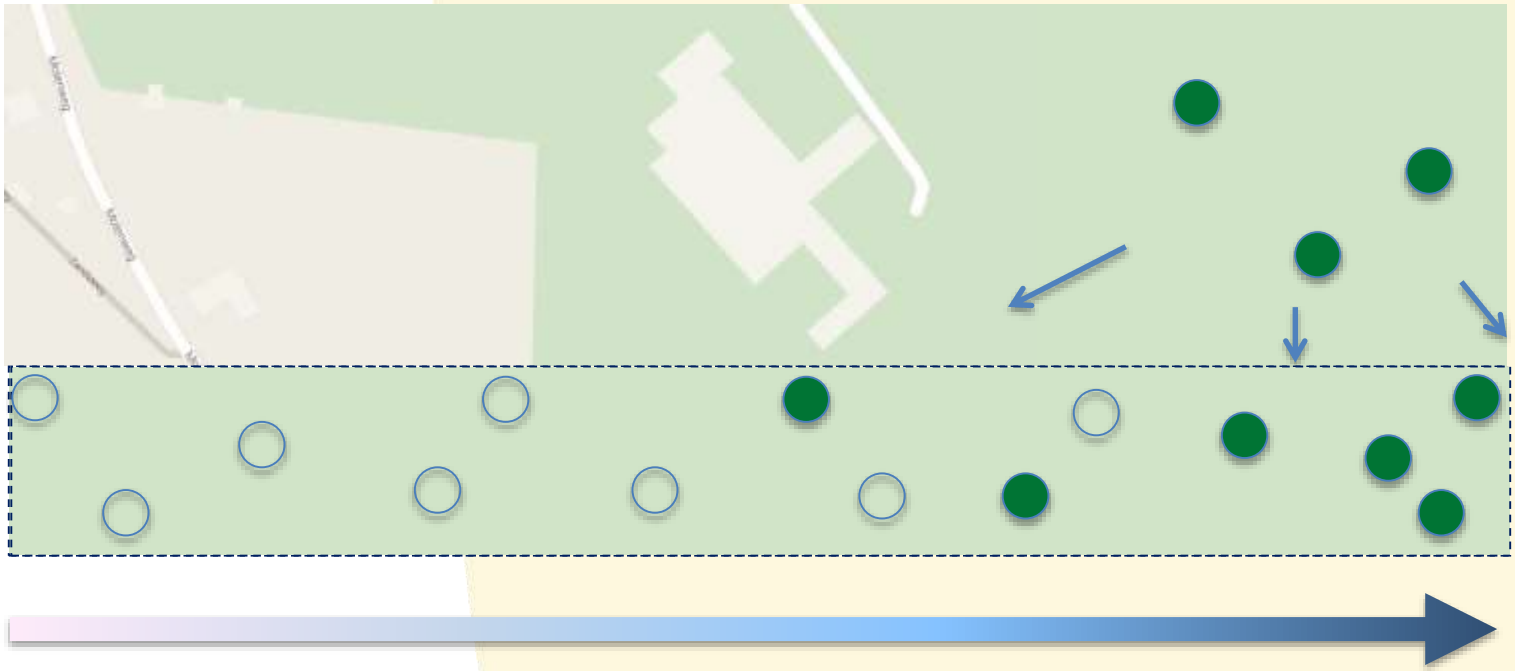


Environmental / dispersal filtering



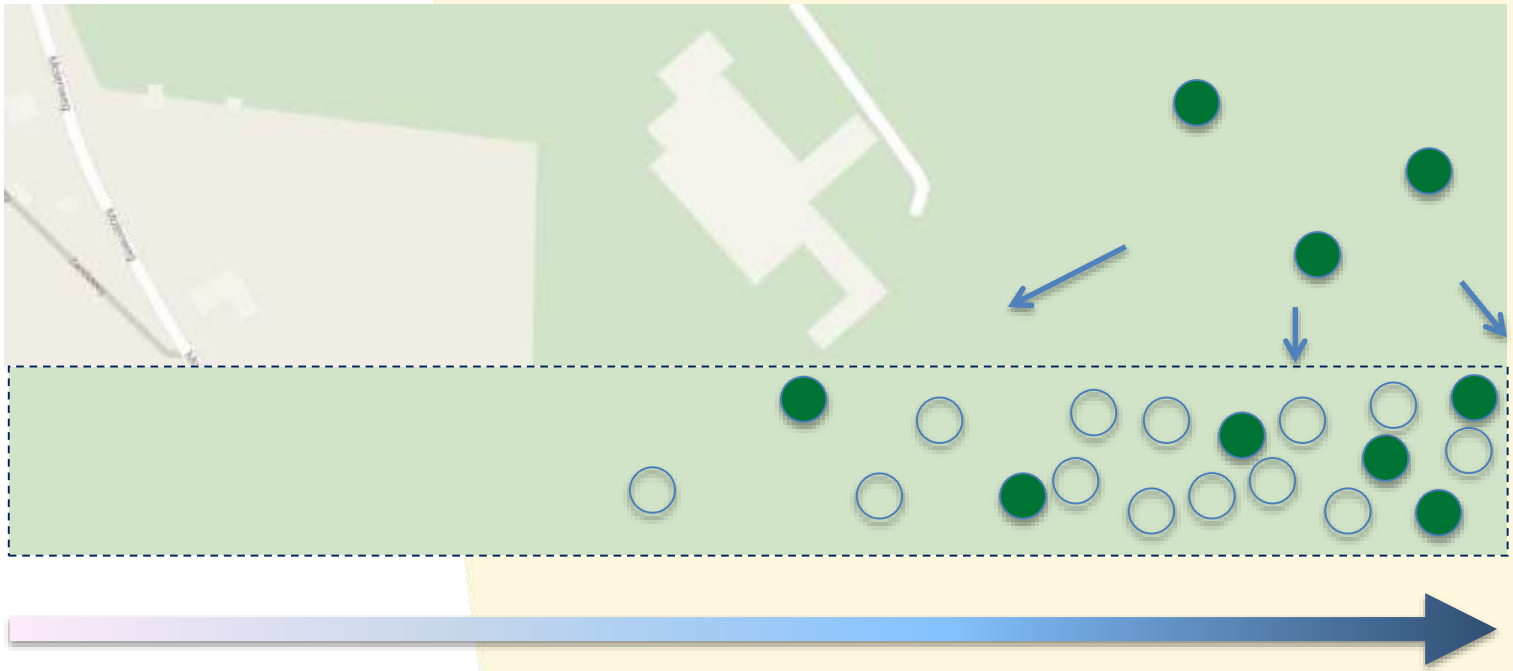
- Environmental filtering
  - Abiotic limitations
  - Biotic interactions

Environmental / dispersal filtering



- Environmental filtering
  - Abiotic limitations
  - Biotic interactions
- Dispersal filtering
  - Dispersal capacities
  - Size of local/regional species pools
  - Chance

Environmental / dispersal filtering



- Environmental filtering
  - Abiotic limitations
  - Biotic interactions
- Dispersal filtering
  - Dispersal capacities
  - Size of local/regional species pools
  - Chance

Stream riparian zones

- Typical example of biodiverse dynamic habitats
- Strong hydrological gradient
- Frequent flooding disturbances
- Highly impacted: regulation, damming, channelization
- Stream and river restoration: but ecological improvement lagging behind

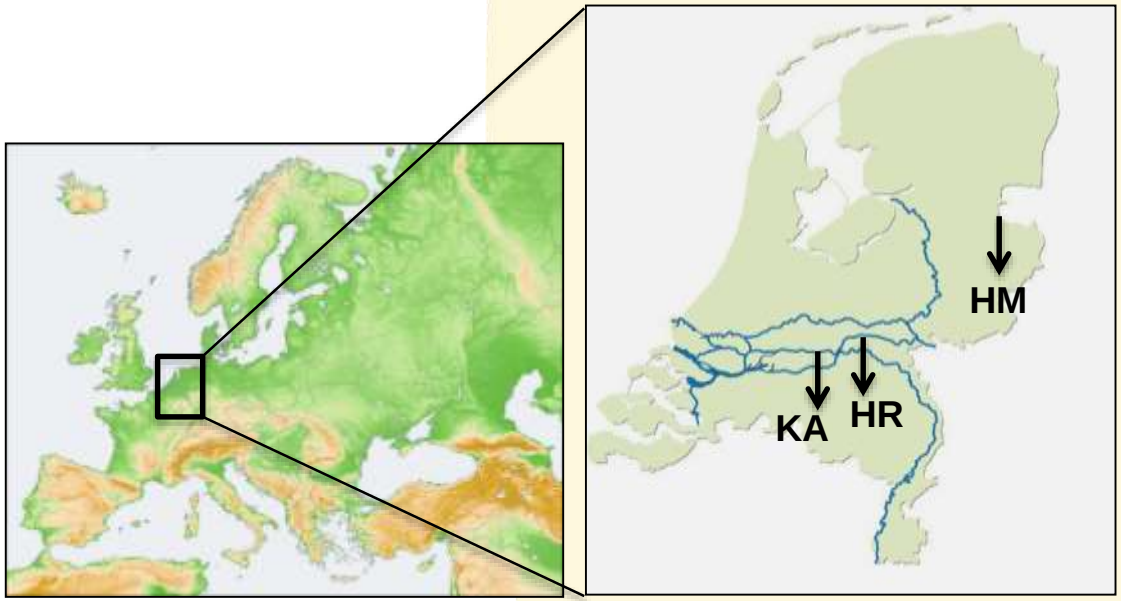
Stream riparian gradient:

1. Do species arrive everywhere?

2. What is the effect of hydrology on establishment?

3. Which steps are most important for eventual species distribution?

Study system



- Lowland streams
- Flat lowland areas
- Fed by rainwater
- Gentle slopes

HM

HR

KA

Methods

Experimental set-up

- Species arrival with seed traps: artifical grass mats 25x25 cm
- Vegetation surveys 25x50 cm: 1 and 2 years after restoration
- Field experiments on germination
- Field experiments on seedling survival and growth

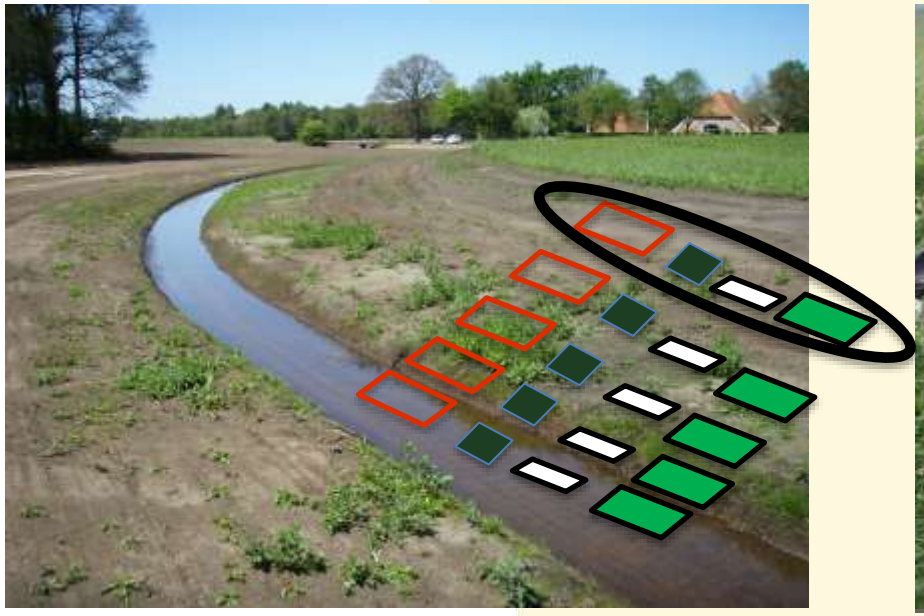
Plant species

Family	Species	Ellenberg Moisture
Ranunculaceae	*Ranunculus lingua*	10
Apiaceae	*Berula erecta*	10
Poaceae	*Glyceria maxima*	10
Ranunculaceae	*Ranunculus flammula*	9
Boraginaceae	*Myosotis scorpioides*	9
Poaceae	*Phalaris arundinacea*	8
Lamiaceae	*Lycopus europaeus*	8
Fabacea	*Lotus pedunculatus*	8
Ranunculaceae	*Ranunculus repens*	7
Caprifoliaceae	*Succisa pratensis*	7
Poaceae	*Anthoxanthum odoratum*	6
Poaceae	*Festuca pratensis*	6
Poaceae	*Alopecurus pratensis*	5
Fabaceae	*Trifolium repens*	5
Polygonaceae	*Rumex acetosa*	5
Asteraceae	*Tragopogon pratensis ssp*	4
Geraniaceae	*Geranium pusilum*	4

Methods

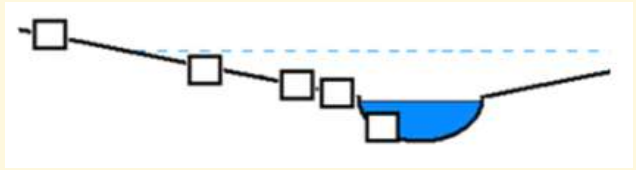
Experimental set-up

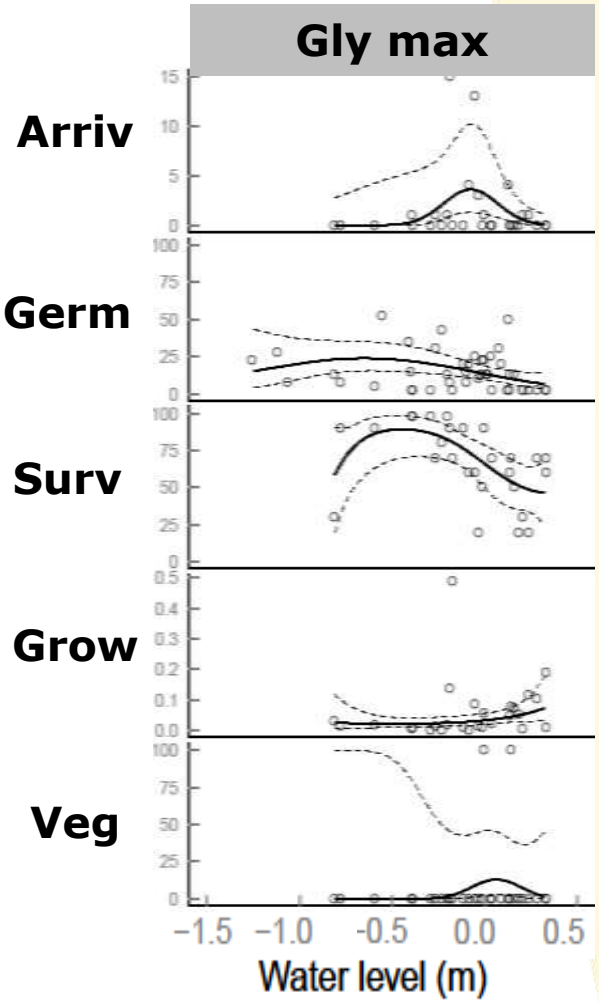
- Species arrival with seed traps: artifical grass mats 25x25 cm
- Vegetation surveys 25x50 cm: 1 and 2 years after restoration
- Field experiments on germination
- Field experiments on seedling survival and growth



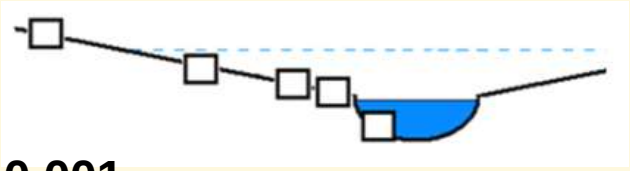
Results

Species patterns



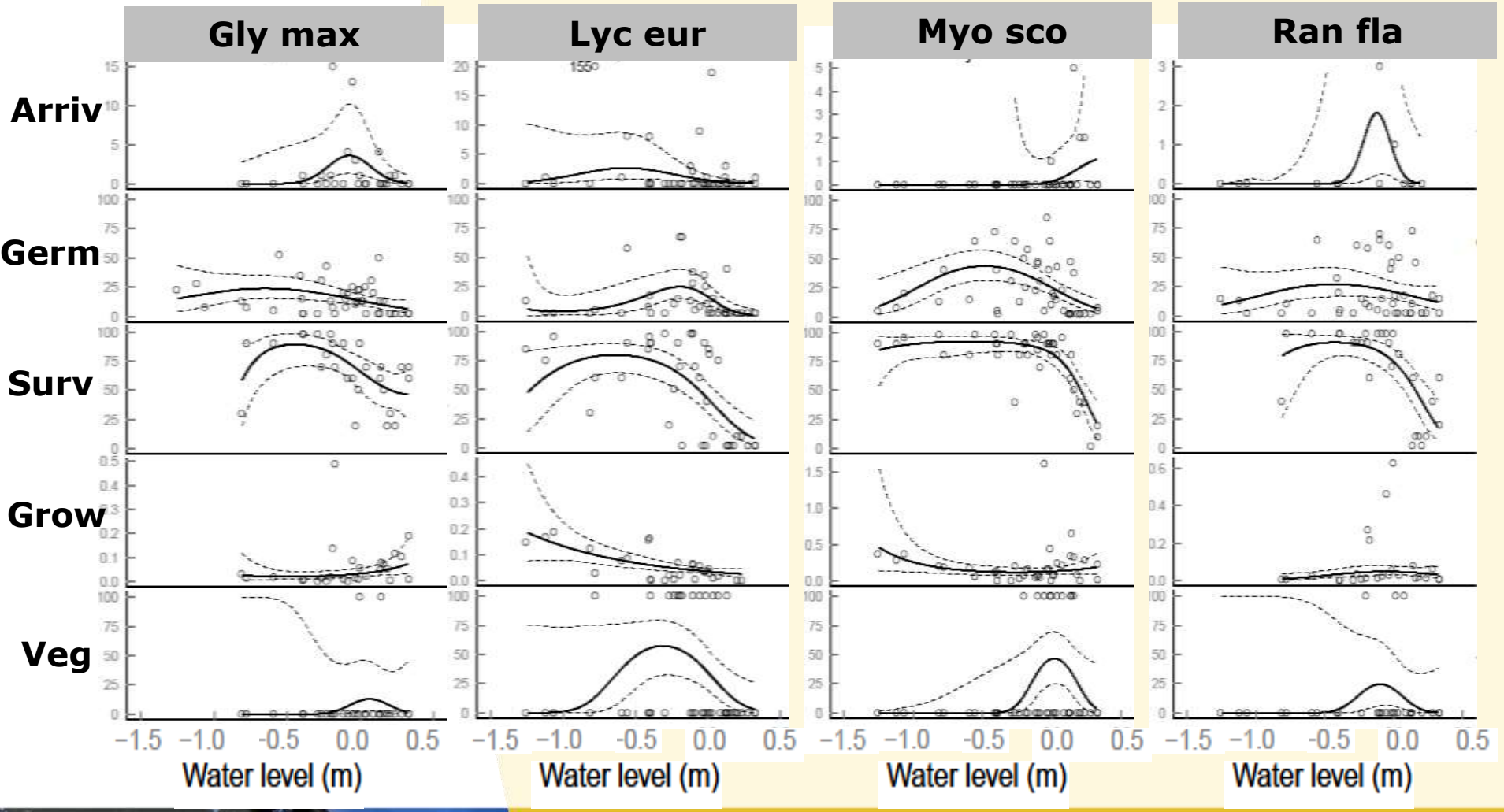


Results

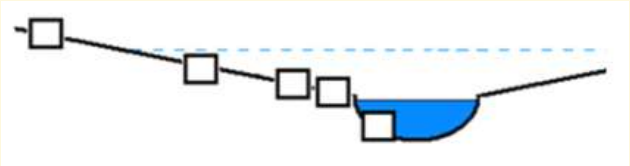


Species patterns

Arrival: $R^2 = 0.35$, $P < 0.001$



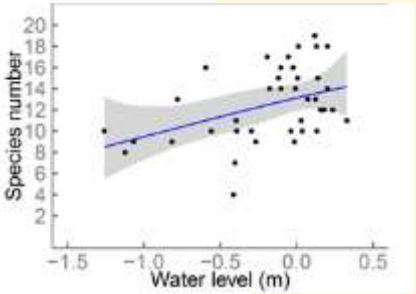
Results



Community patterns

Species number

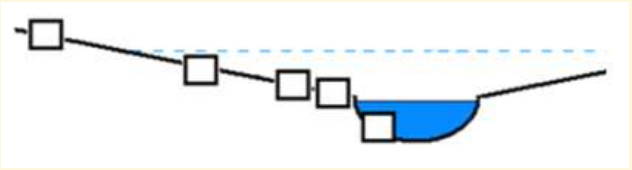
Seed arrival



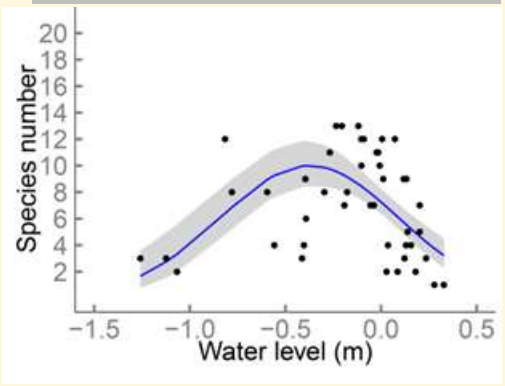
Results

Community patterns

Species number



Vegetation

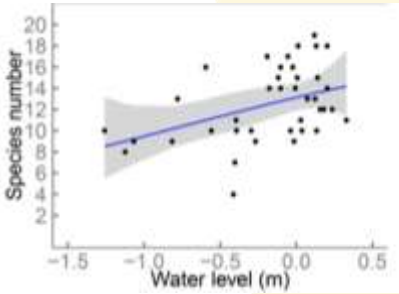


$R^2 = 0.19$
$P = 0.004$

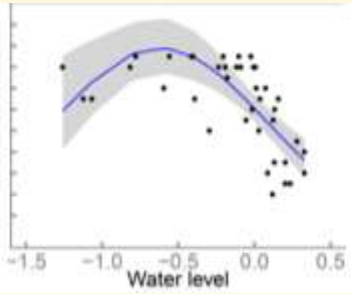
$R^2 = 0.41$
$P < 0.001$

$R^2 = 0.67$
$P < 0.001$

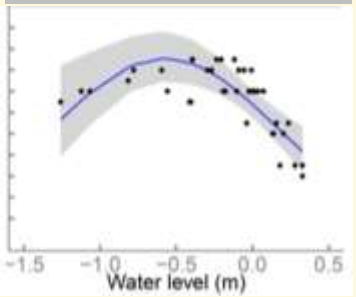
Seed arrival



Germination



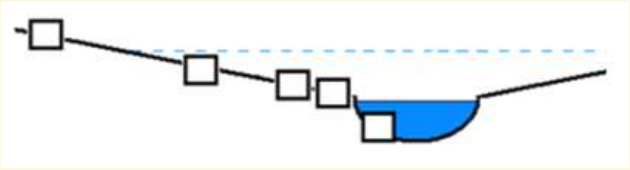
Seedling survival



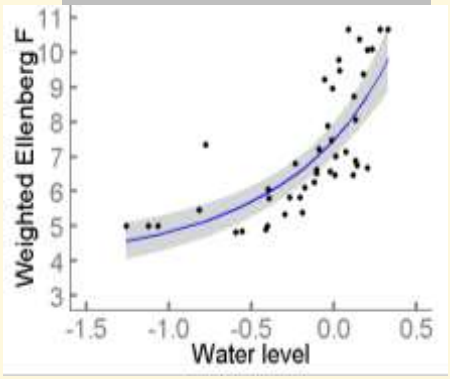
Results

Community patterns

Weighted Ellenberg F



Vegetation



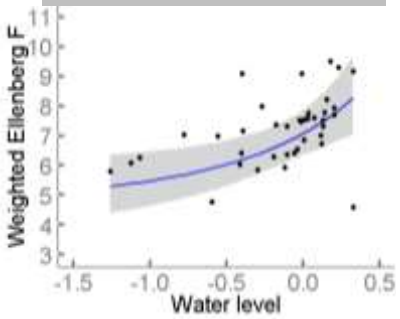
$R^2 = 0.52$
$P < 0.001$

$R^2 = 0.15$
$P = 0.008$

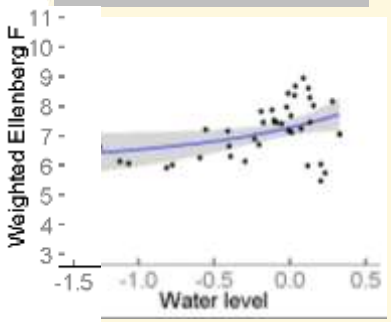
$R^2 = 0.57$
$P < 0.001$

$R^2 = 0.61$
$P < 0.001$

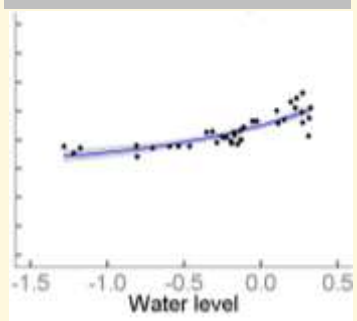
Seed arrival



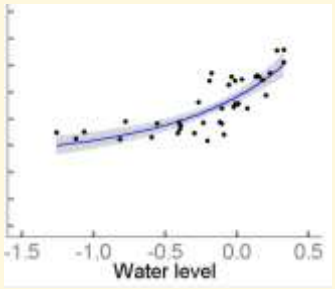
Germination



Seedling survival



Seedling growth



Results & Discussion

Stream riparian gradient:

1. Do species arrive everywhere?

No: floodplain, waterline, drift lines

2. What is the effect of hydrology on establishment?

Strong environmental filtering particularly by flooding

3. Which steps are most important for eventual species distribution?

For several species: place of arrival most important

For community: strong effects of seedling survival and growth, **but also by seed arrival**

→ Still early successional stage

Implications

- Dynamic habitats: importance of both dispersal filtering and environmental filtering
- Protect source populations and natural **flooding dynamics that promote seed deposition**
- Wide and fluent hydrological gradients provide space for individual species requirements → promotes biodiversity

Acknowledgements

Thank you! Questions?

- Many colleagues and students
- Waterboards Aa & Maas, Dommel, Regge & Dinkel
- Botanical garden Utrecht
- Funding: Agency NL and STOWA










Agentschap NL
Ministerie van Economische Zaken, Landbouw en Innovatie

Universiteit Utrecht

stowa