‘The dispersal and deposition of plant propagules in groundwater-fed rivers: linking hydrology and ecology’

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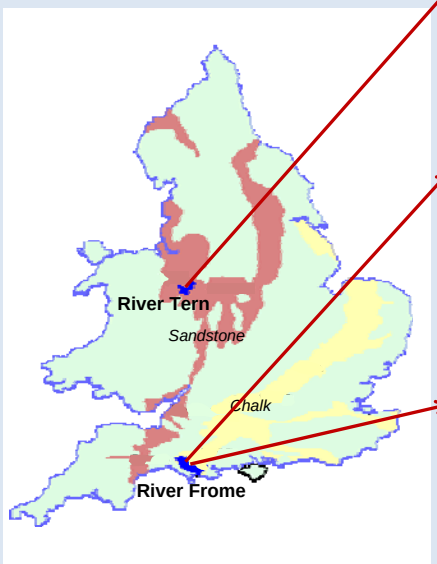
The Study Sites

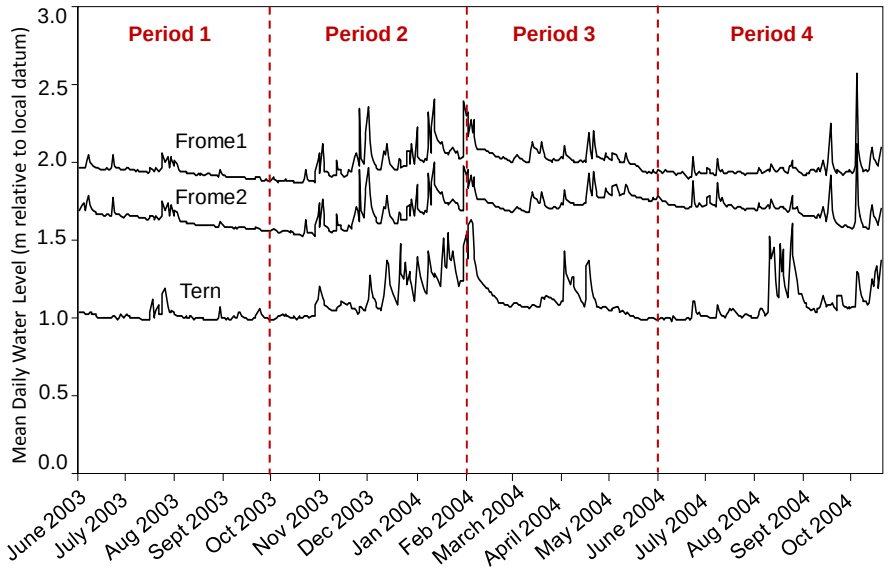


Tern

Frome1

Frome2

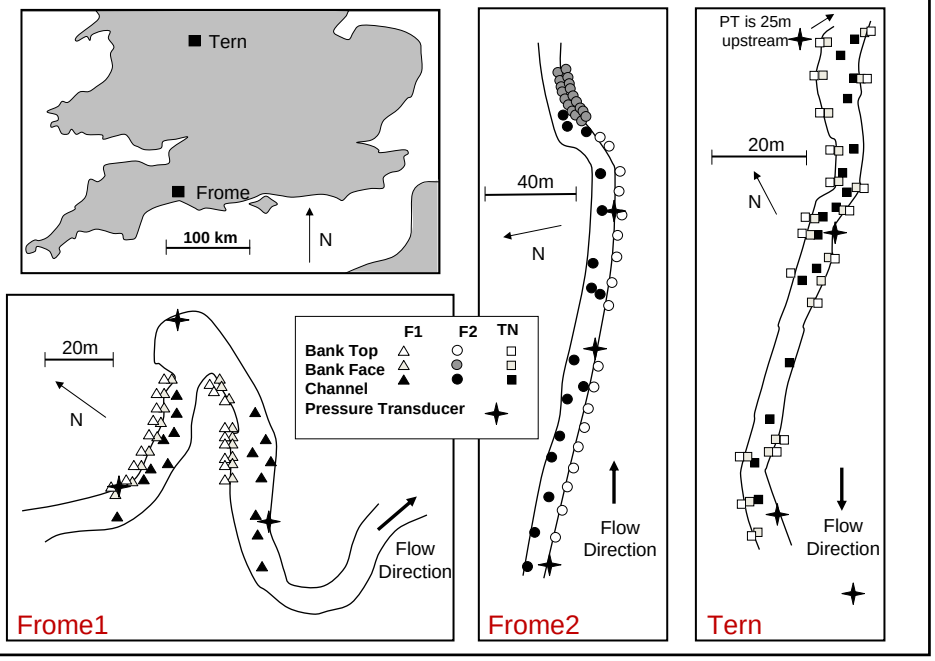
Water Levels over Study Period



Propagule deposition along river margins

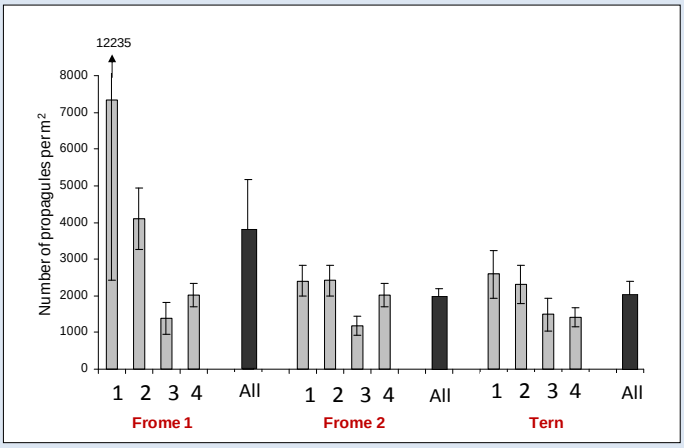
- Propagule bank sampled at 'top' and 'mid' locations using a bulb planter
- Propagule bank in the channel measured using an aston sampler
- Propagule deposition measured at 'top', 'mid' and 'channel' locations using astroturf mats
- Environmental properties of mats measured: elevation, inundation, weight of sediment, fine sediment and organic matter
- Vegetation survey conducted June 2004

Sample Design

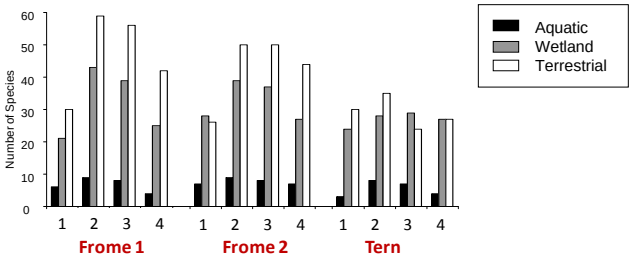


Results: Propagule Deposition

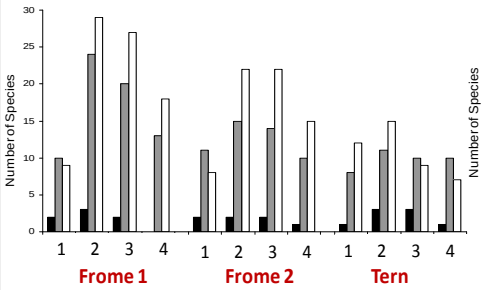
- 104,818 viable propagules
- 172 species
- On average ca. 1500 propagules/m^2 and 40 species deposited every 4 months at each sampling point



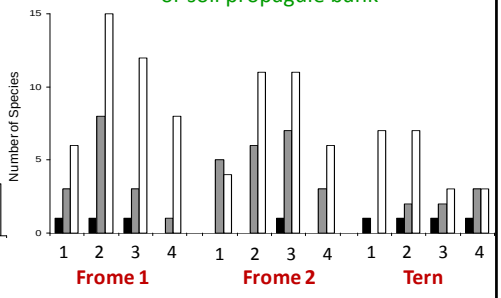
Total deposited propagules

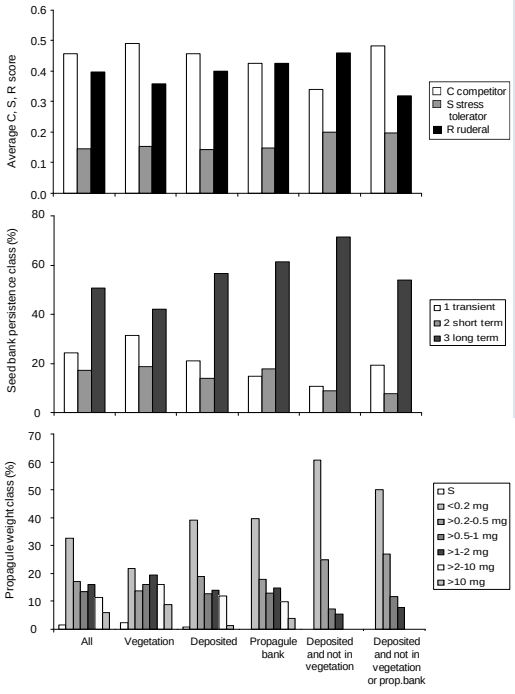


Species not present in the riparian vegetation



Species not present in the riparian vegetation or soil propagule bank





Propagule Characteristics

Plant Strategy

•Depositional samples have significantly higher S and R scores than the vegetation
•Ruderal species are better suited for colonising disturbed ground

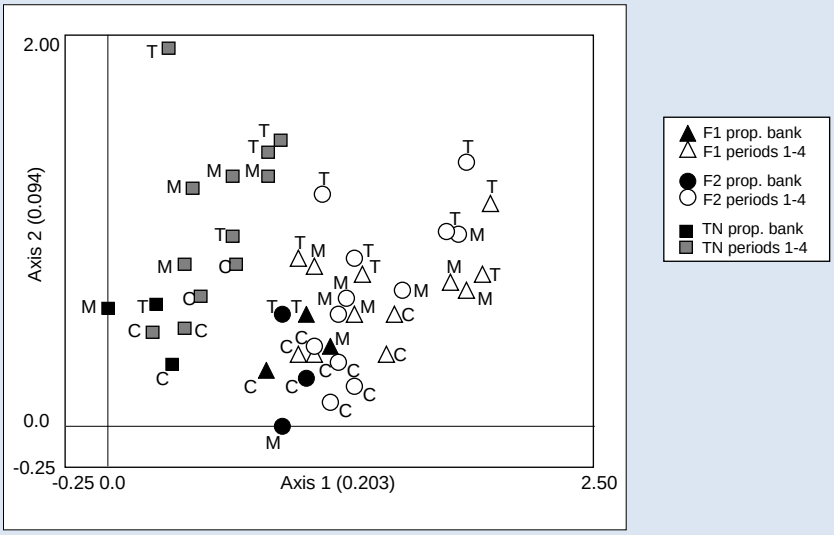
Propagule Bank Formation

•Both propagule bank and depositional samples form longer term seed banks than the vegetation
•This facilitates widespread dispersal and longevity in the fluvial system

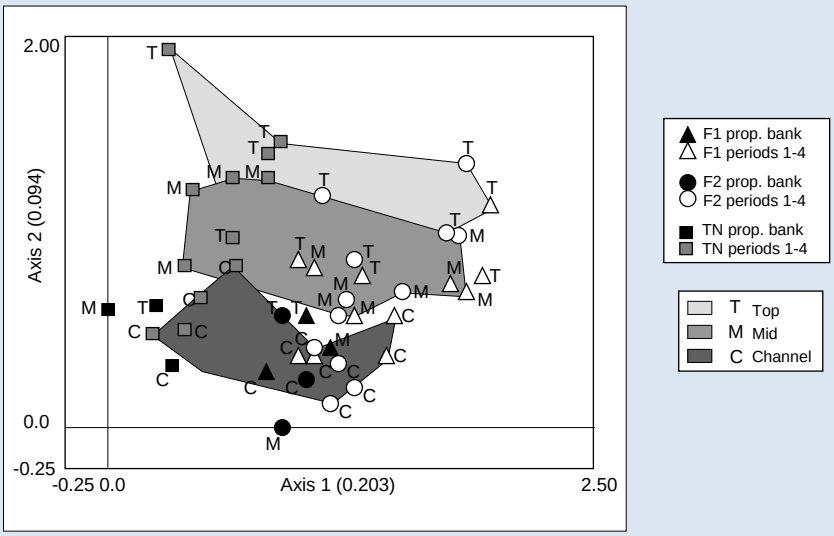
Propagule Weight

•Both propagule bank and depositional samples have significantly lighter seeds than the vegetation, which facilitates long distance transport and more widespread deposition

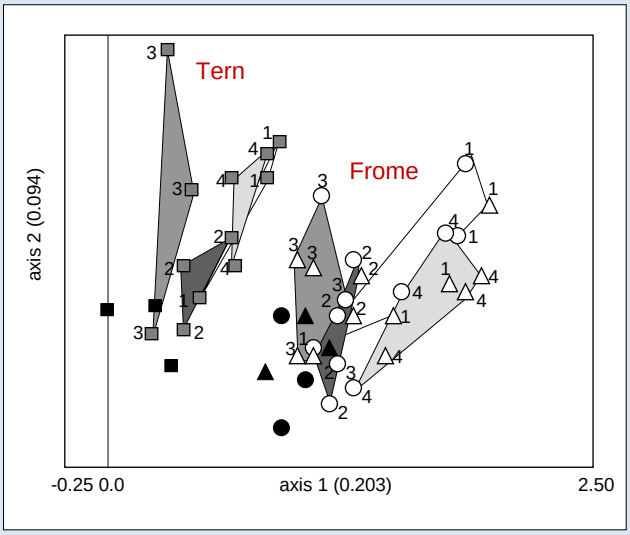
Floristic Composition of Samples



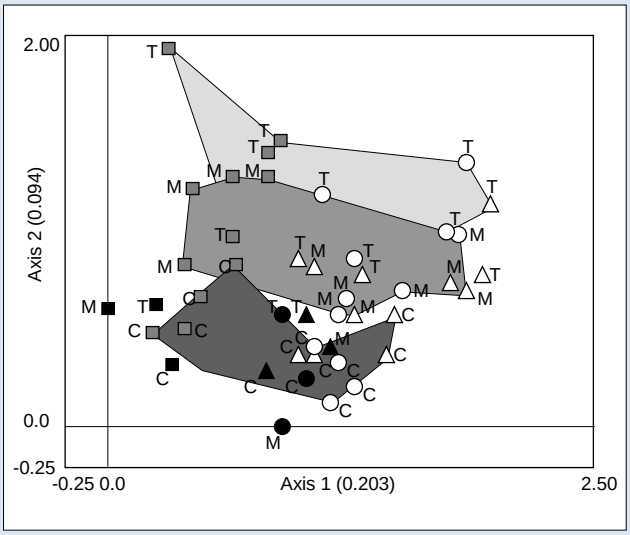
Floristic Composition of Samples



Floristic Composition of Samples



Floristic Composition of Samples



Plant functional type
C score **0.401**
R score -0.335

Propagule bank
Transient **0.494**
Long-term **-0.539**

Propagule weight
> 2-10 mg **0.433**
>10 mg **-0.533**

Significant at 0.01 level
Significant at 0.05 level

Propagule deposition and fluvial processes

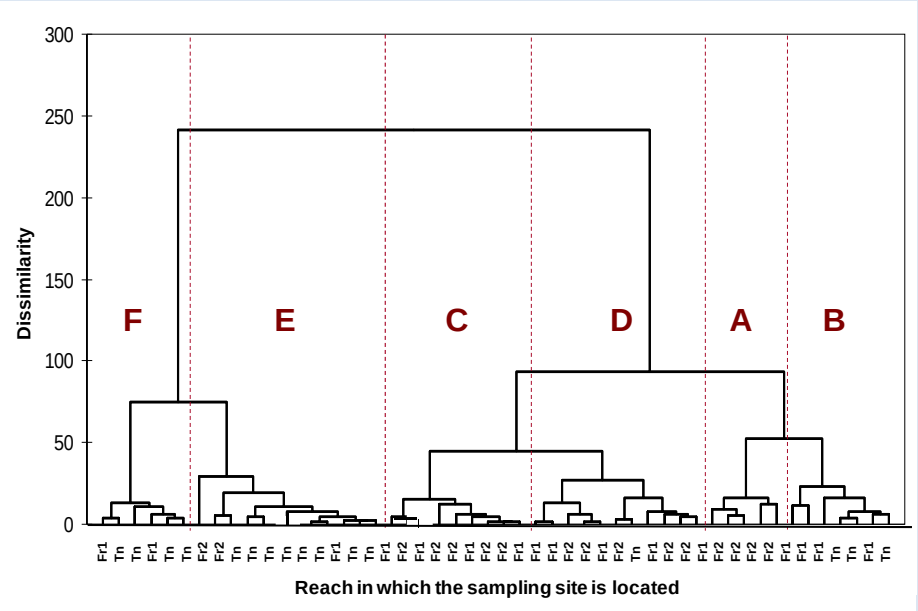
	Number of propagules (m^2)			Number of propagules not in vegetation			Number of species			Number of species not in vegetation		
	Frome1	Frome2	Tern	Frome1	Frome2	Tern	Frome1	Frome2	Tern	Frome1	Frome2	Tern
Period 1												
Sample Size	36	36	36	36	36	36	36	36	36	36	36	36
%Inund	**0.423**	0.115	0.314	0.218	-0.096	0.112	**0.522**	0.111	0.282	0.161	-0.117	0.076
EMWL	**-0.624**	0.047	*-0.417*	*-0.403*	-0.158	-0.145	**-0.609**	-0.013	*-0.399*	-0.290	-0.040	-0.275
Period 2												
Sample Size	36	36	38	36	36	38	36	36	38	36	36	38
%Inund	*0.360*	**0.448**	*0.344*	0.307	**0.449**	0.320	0.225	**0.639**	*0.393*	0.273	**0.549**	0.306
EMWL	**-0.619**	**-0.536**	**-0.524**	**-0.528**	**-0.668**	**-0.513**	**-0.482**	**-0.774**	**-0.603**	**-0.550**	**-0.678**	**-0.528**
WtSediment	**0.777**	**0.640**	**0.442**	**0.755**	**0.643**	**0.496**	**0.848**	**0.914**	**0.541**	**0.876**	**0.867**	**0.551**
WtOrganic	**0.769**	**0.569**	**0.543**	**0.682**	**0.596**	**0.500**	**0.816**	**0.774**	**0.495**	**0.863**	**0.774**	**0.509**
WtFinesed	**0.802**	**0.637**	**0.546**	**0.742**	**0.629**	**0.587**	**0.839**	**0.867**	**0.625**	**0.880**	**0.853**	**0.592**
Period 3												
Sample Size	35	34	34	35	34	34	35	34	34	35	34	34
%Inund	0.323	**0.473**	**0.472**	0.055	*0.356*	0.220	0.191	**0.508**	*0.419*	0.174	**0.493**	*0.342*
EMWL	**-0.451**	**-0.828**	**-0.675**	*-0.358*	**-0.448**	-0.253	**-0.470**	**-0.691**	**-0.641**	**-0.455**	**-0.524**	*-0.385*
WtSediment	**0.848**	**0.702**	**0.795**	**0.727**	**0.519**	*0.393*	**0.909**	**0.935**	**0.674**	**0.872**	**0.862**	**0.592**
WtOrganic	**0.764**	**0.824**	**0.757**	**0.686**	**0.570**	*0.366*	**0.881**	**0.925**	**0.763**	**0.890**	**0.812**	**0.648**
WtFinesed	**0.738**	**0.853**	**0.665**	**0.692**	**0.568**	0.276	**0.737**	**0.955**	**0.673**	**0.723**	**0.875**	**0.666**
Period 4												
Sample Size	36	35	37	36	35	37	36	35	*37*	36	35	*37*
%Inund	0.289	0.148	0.069	0.236	0.226	0.133	*0.392*	0.301	0.205	0.041	0.133	0.116
EMWL	*-0.421*	**-0.547**	*-0.385*	-0.236	-0.306	-0.290	**-0.573**	*-0.403*	**-0.507**	-0.259	-0.290	*-0.348*
WtSediment	**0.532**	**0.520**	0.254	**0.480**	**0.677**	**0.725**	**0.707**	**0.780**	*0.400*	*0.421*	**0.725**	**0.596**
WtOrganic	**0.656**	**0.471**	*0.407*	**0.469**	**0.479**	*0.415*	**0.672**	**0.545**	**0.426**	*0.376*	*0.415*	*0.381*
WtFinesed	*0.334*	**0.563**	0.286	*0.337*	**0.605**	**0.567**	**0.443**	**0.700**	*0.397*	*0.335*	**0.567**	**0.497**
Overall Average												
Sample Size	35	33	34	35	33	34	35	33	34	35	33	34
%Inund	**0.536**	*0.349*	*0.377*	0.283	*0.413*	0.089	0.321	**0.545**	*0.359*	0.211	**0.448**	0.263
EMWL	**-0.742**	**-0.592**	**-0.639**	**-0.569**	**-0.573**	-0.284	**-0.601**	**-0.699**	**-0.715**	**-0.518**	**-0.580**	**-0.648**
WtSediment	**0.753**	**0.635**	**0.512**	**0.821**	**0.760**	0.164	**0.877**	**0.941**	**0.559**	**0.844**	**0.886**	**0.652**
WtOrganic	**0.729**	**0.623**	**0.629**	**0.795**	**0.694**	0.206	**0.864**	**0.816**	**0.604**	**0.875**	**0.760**	**0.557**
WtFinesed	**0.702**	**0.680**	**0.580**	**0.823**	**0.773**	0.173	**0.784**	**0.919**	**0.602**	**0.793**	**0.870**	**0.624**

Significant at the 0.01 level Significant at the 0.05 level

Where are propagules stored in the river channel?

- Environmental properties recorded during sampling:
  - Bed Sediment Calibre
  - Surface Sediment Calibre
  - Nearest vegetation
  - Position with regard to vegetation
  - Nearest macrophytes
  - Location with regard to macrophytes

River channel habitat classification



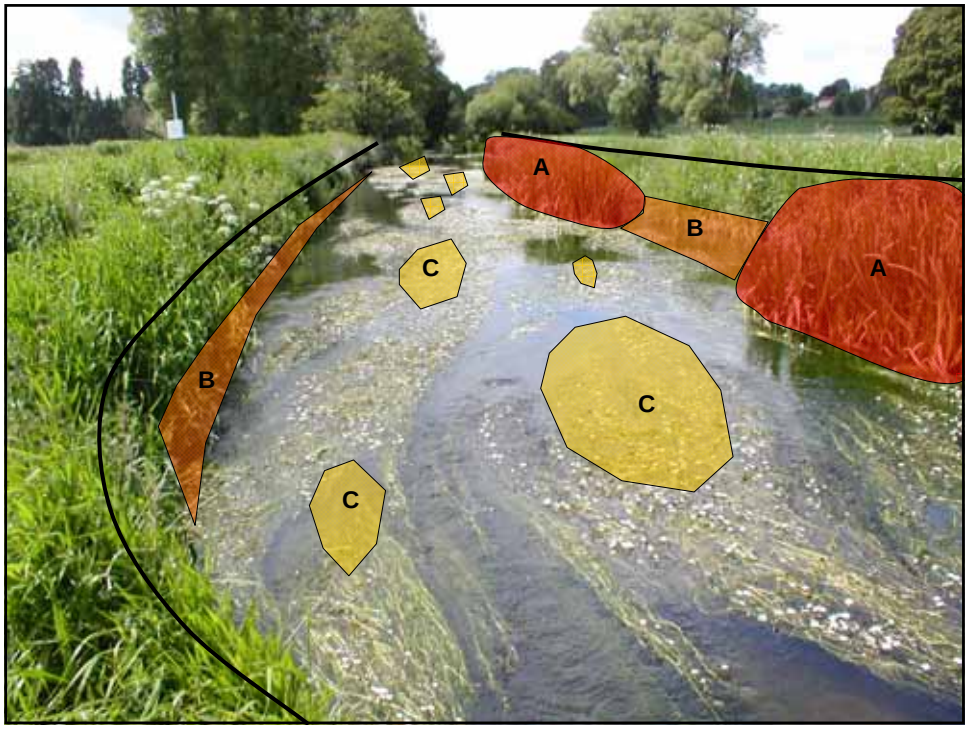
Class	A	B	C	D	E	F
Bed Sediment Calibre	silt	sand	gravel	sand /gravel	silt /sand	gravel
Surface Sediment Calibre	silt	sand	sand /gravel	sand /gravel	silt /sand	gravel
Nearest vegetation	emergents	trees/ riparian herbs	aquatics	aquatics	none	none
Position w.r.t. vegetation	Within <1m DS	<1m DS	within /edge	edge /between	no veg	no veg
Nearest macrophytes	*Sparganium erectum*	*Phalaris arundacea* *Ranunculus. Penicillatus*	*Ranunculus penicillatus*	*Ranunculus penicillatus* *Myriophyllum spicatum*	no macrophytes	no macrophytes
Location w.r.t. macrophytes	within /between	none /upstream of macrophytes	within /between	between /upstream	no macrophytes	no macrophytes

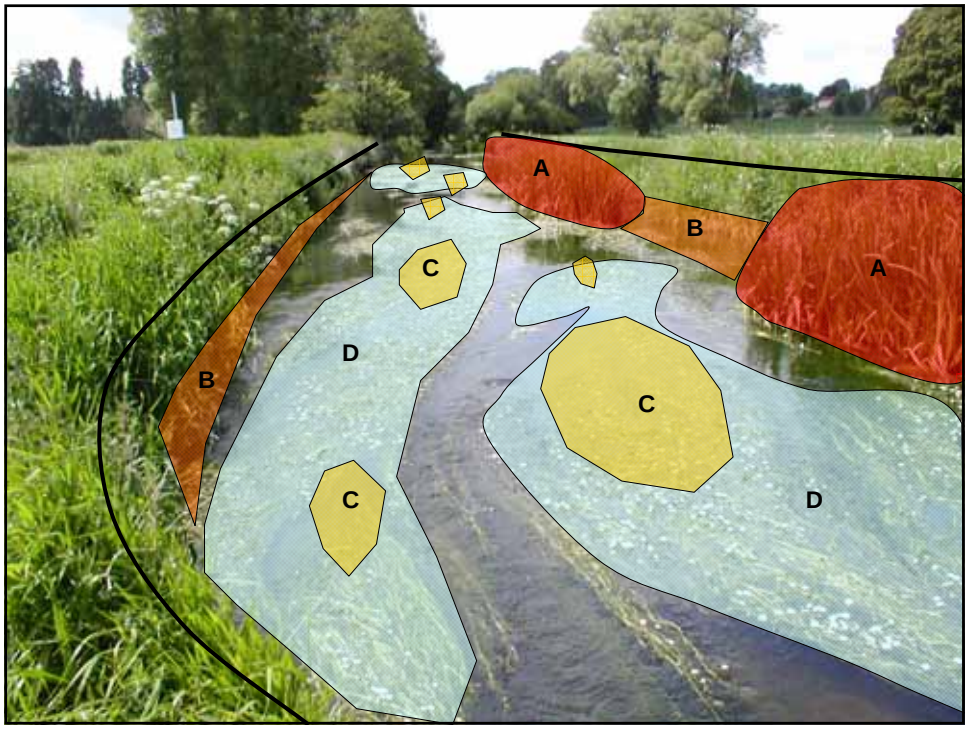
Class	A	B	C	D	E	F
Bed Sediment Calibre	silt	sand	gravel	sand /gravel	silt /sand	gravel
Surface Sediment Calibre	silt	sand	sand /gravel	sand /gravel	silt /sand	gravel
Nearest vegetation	emergents	trees/ riparian herbs	aquatics	aquatics	none	none
Position w.r.t. vegetation	Within <1m DS	<1m DS	within /edge	edge /between	no veg	no veg
Nearest macrophytes	*Sparganium erectum*	*Phalaris arundacea Ranunculus. Penicillatus*	*Ranunculus penicillatus*	*Ranunculus penicillatus Myriophyllum spicatum*	no macrophytes	no macrophytes
Location w.r.t. macrophytes	within /between	none /upstream of macrophytes	within /between	between /upstream	no macrophytes	no macrophytes
Number of species	**11**	**10**	**8**	**6**	**8**	**4**
Propagules/m^2	**660**	**320**	**360**	**167**	**300**	**65**
Species: A>D,F Propagules: A>D,F C>F						

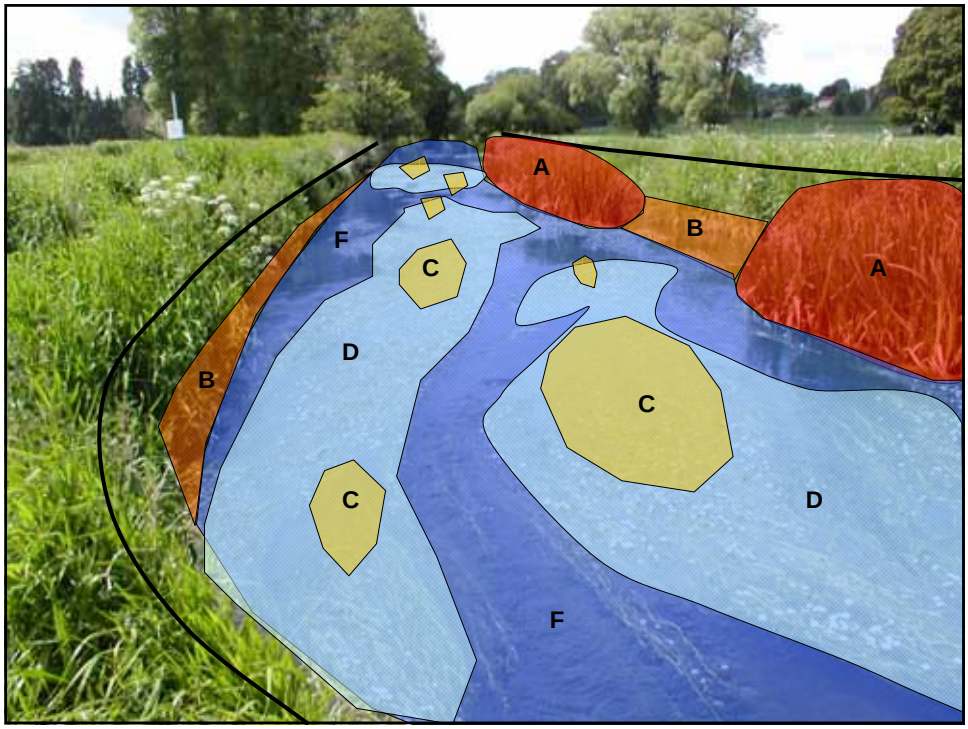
Class	A	B	C	D	E	F
Bed Sediment Calibre	silt	sand	gravel	sand /gravel	silt /sand	gravel
Surface Sediment Calibre	silt	sand	sand /gravel	sand /gravel	silt /sand	gravel
Nearest vegetation	emergents	trees/ riparian herbs	aquatics	aquatics	none	none
Position w.r.t. vegetation	Within <1m DS	<1m DS	within /edge	edge /between	no veg	no veg
Nearest macrophytes	*Sparganium erectum*	*Phalaris arundacea Ranunculus. Penicillatus*	*Ranunculus penicillatus*	*Ranunculus penicillatus Myriophyllum spicatum*	no macrophytes	no macrophytes
Location w.r.t. macrophytes	within /between	none /upstream of macrophytes	within /between	between /upstream	no macrophytes	no macrophytes
Number of species	**11**	**10**	**8**	**6**	**8**	**4**
Propagules/m^2	**660**	**320**	**360**	**167**	**300**	**65**
Species: A>D,F Propagules: A>D,F C>F						


A
A


A
B
A
B


A
B
A
C
B
C
C


A
B
A
C
D
B
C
C
D


A
B
A
F
C
D
B
C
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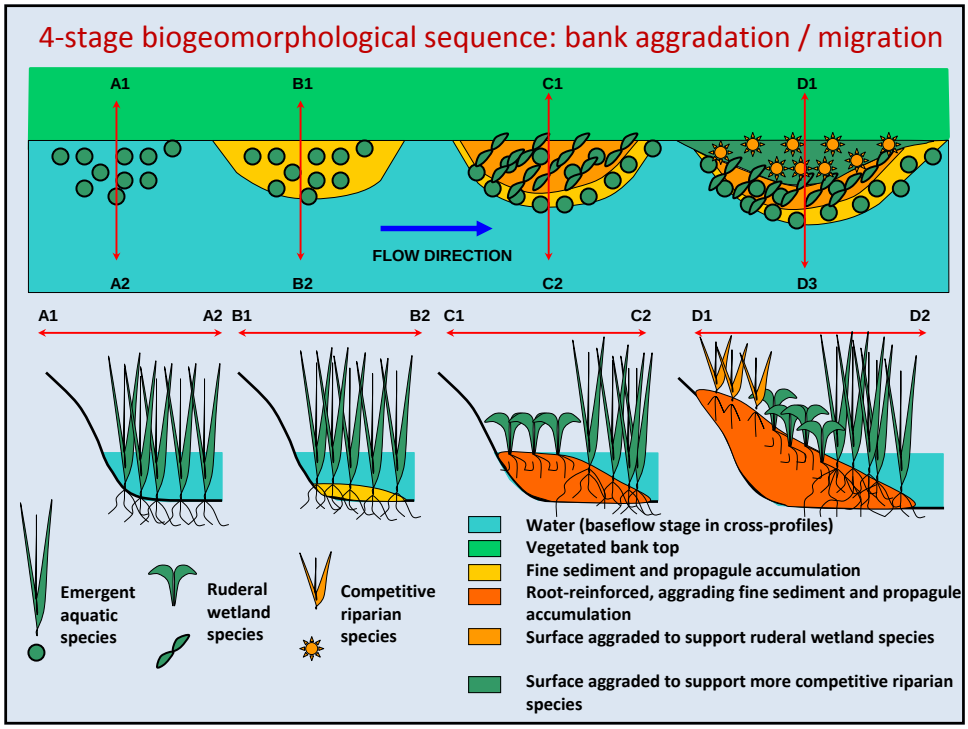
D
F


4-stage biogeomorphological sequence: bank aggradation / migration
A1
B1
C1
D1
FLOW DIRECTION
A2
B2
C2
D3
A1
A2
B1
B2
C1
C2
D1
D2
Emergent aquatic species
Ruderal wetland species
Competitive riparian species
Water (baseflow stage in cross-profiles)
Vegetated bank top
Fine sediment and propagule accumulation
Root-reinforced, aggrading fine sediment and propagule accumulation
Surface aggraded to support ruderal wetland species
Surface aggraded to support more competitive riparian species

Summary and Conclusions

- Hydrochory is important for introducing new species and for remobilising propagules. This process is intrinsically linked to the hydrological regime.
- Species that were not present in the vegetation were characterised by propagules which were lighter and form longer term seed banks, making them suitable for long-distance transport.
- The riverbed is an important store of viable propagules, which are remobilised and deposited within the riparian zone during high flows.
- River channel and emergent vegetation facilitates the accumulation of sediment and propagules in the riparian zone, which has geomorphological feedbacks.

➢ In low-energy, groundwater fed systems such as the River Frome and the River Tern, high river flows are important for facilitating the transport and deposition of propagules in the riparian zone, which is important for maintaining habitat complexity and riparian vegetation diversity.

Thank-you for your attention.

- Relevant publications:
  - Gurnell, A., Thompson, K., Goodson, J. and Moggridge, H. (2008) Propagule deposition along river margins: linking hydrology and ecology. *Journal of Ecology*, **96**, 553-565
  - Moggridge, H., Gurnell, A.G. and Mountford, O.J. (2008) Propgaule input, transport and deposition in riparian environments: the importance of connectivity for diversity. *Journal of Vegetation Science, in press*
  - Gurnell, A., Goodson, J., Thompson, K., Clifford, N. and Armitage, P. (2007) The river-bed: a dynamic store for plant propagules? *Earth Surface processes and Landforms*, **32**, 1257-1272
  - Gurnell, A.M., van Oosterhout, M.P., de Vlieger, B., Goodson, J.M. (2006) Reach-scale impacts of aquatic plant growth on physical habitat. *River Research and Applications*, **22**, 667-680.

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