

How many plant species are there in German floodplains?

Estimating the richness of vascular plant species
based on a data base of floodplain vegetation plots

Peter Horchler

German Federal Institute of Hydrology

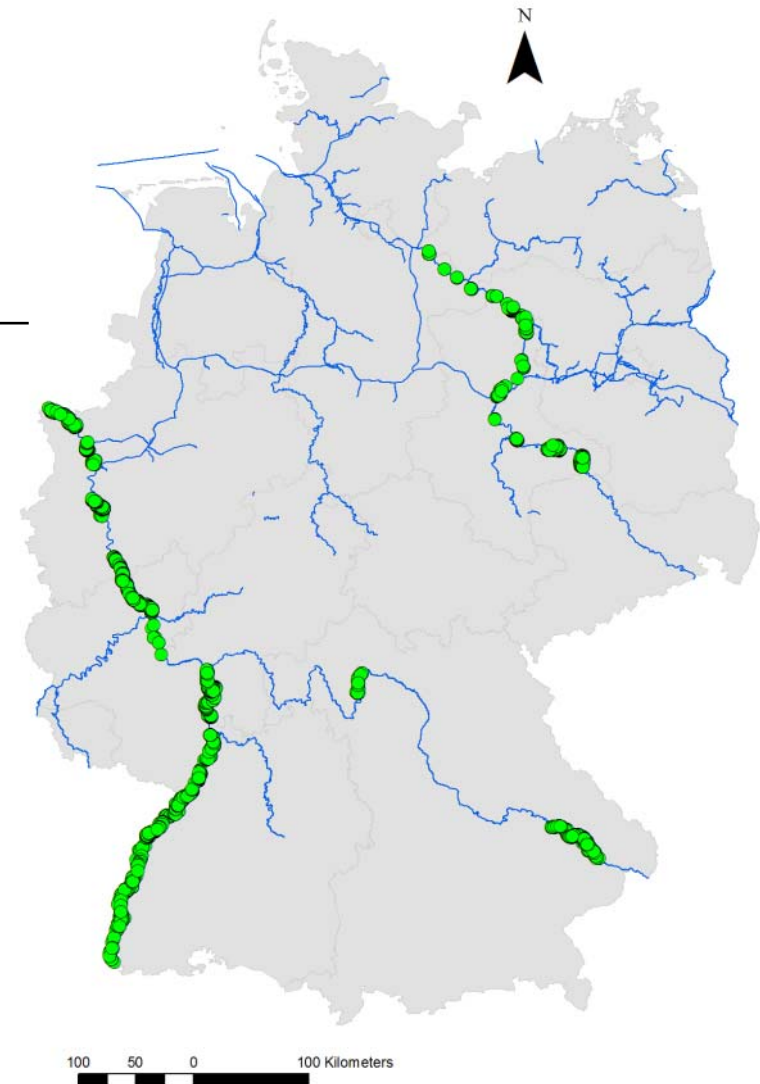
Department Ecological Interactions

Why estimating the phytodiversity of floodplains?

- High species richness expected, is this true?
- Basis information to support national and EU wide strategies to fight biodiversity loss
- Basis information for the success of restoration projects

The TV data base

River	Length consid.	No. of relevés	No. of species
All	963	5159	1066
Rhine	500	2091	754
Danube	70	2158	702
Elbe	370	696	486
Main	23	71	198



Methods

1. Species counts (R package vegdata: TV imp. & taxon. filter)

Jansen F., Dengler J. (2010)

2a. Species estimates (R package vegan: function: specpool)

Oksanen J. et al. (2013)

Estimators:

Chao	$E = S + a1^2/(2*a2)$
First order jackknife	$E = S + a1*(N-1)/N$
Second order jackknife	$E = S + a1*(2*N-3)/nN - a2*(N-2)^2/N/(N-1)$
Bootstrap	$E = S + \text{Sum } (1-p_i)^N$

E extrapolated richness in a pool

S observed number of species in the sample

$a1$ number of species occurring only in one sample

$a2$ number of species occurring only in two sites in the sample

p_i is the frequency of species i

N is the number of sites in the collection.

Colwell, R.K. & Coddington, J.A. (1994)

Methods

2b Species estimates (Frees software EstimateS)

Colwell, R. K. 2013. Version 9. <http://purl.oclc.org/estimates>.

3. Noise Clustering (R package vegclust)

De Cáceres, M., Font, X., Oliva, F. (2010)

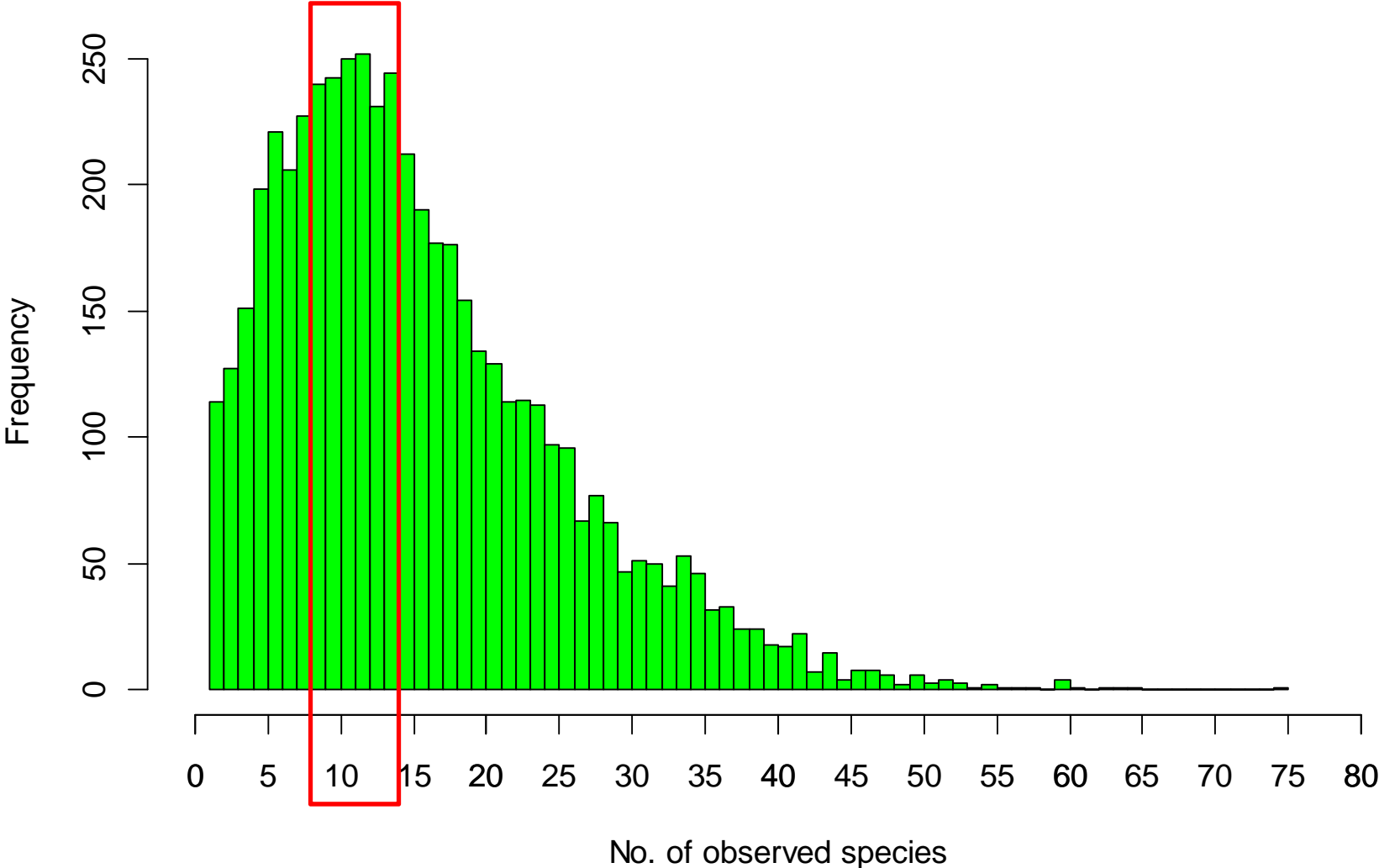
4. Calculation of beta diversity as total variation of data

Legendre, P. & De Cáceres, M. (2013)

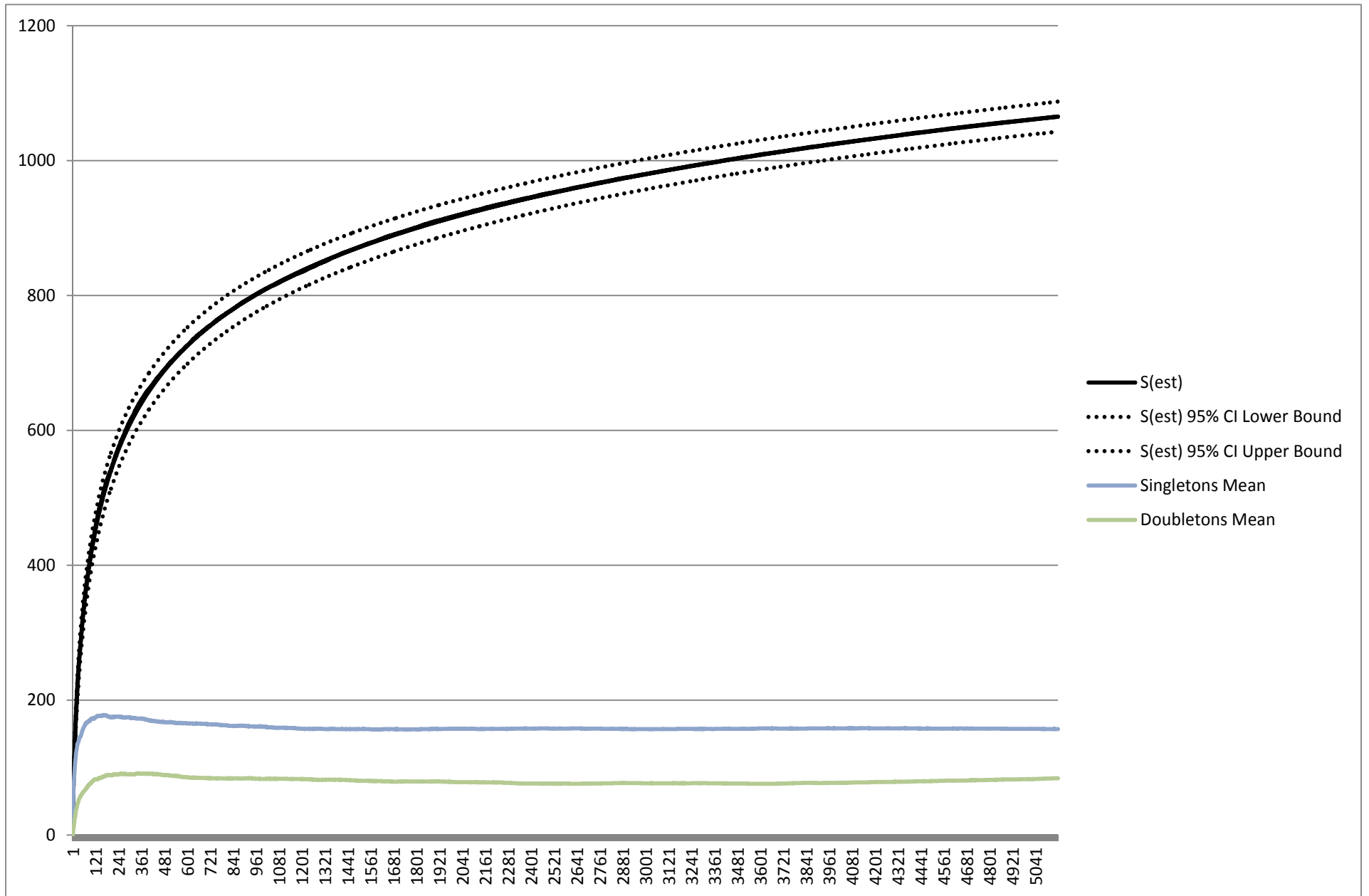
Results

All rivers: Rhine, Danube, Elbe & Main

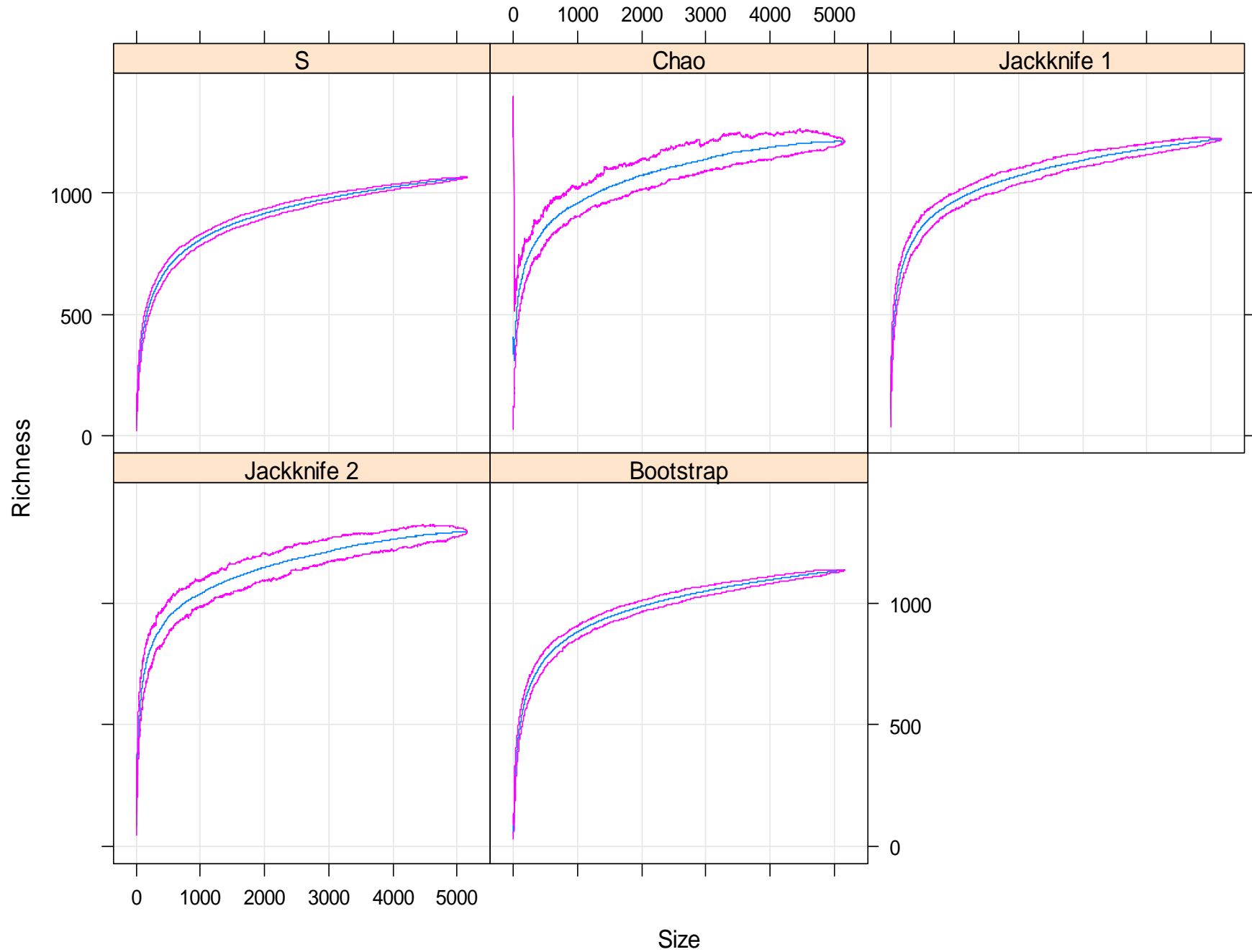
All rivers: Distribution of species numbers



All rivers: species accumulation (EstimateS)

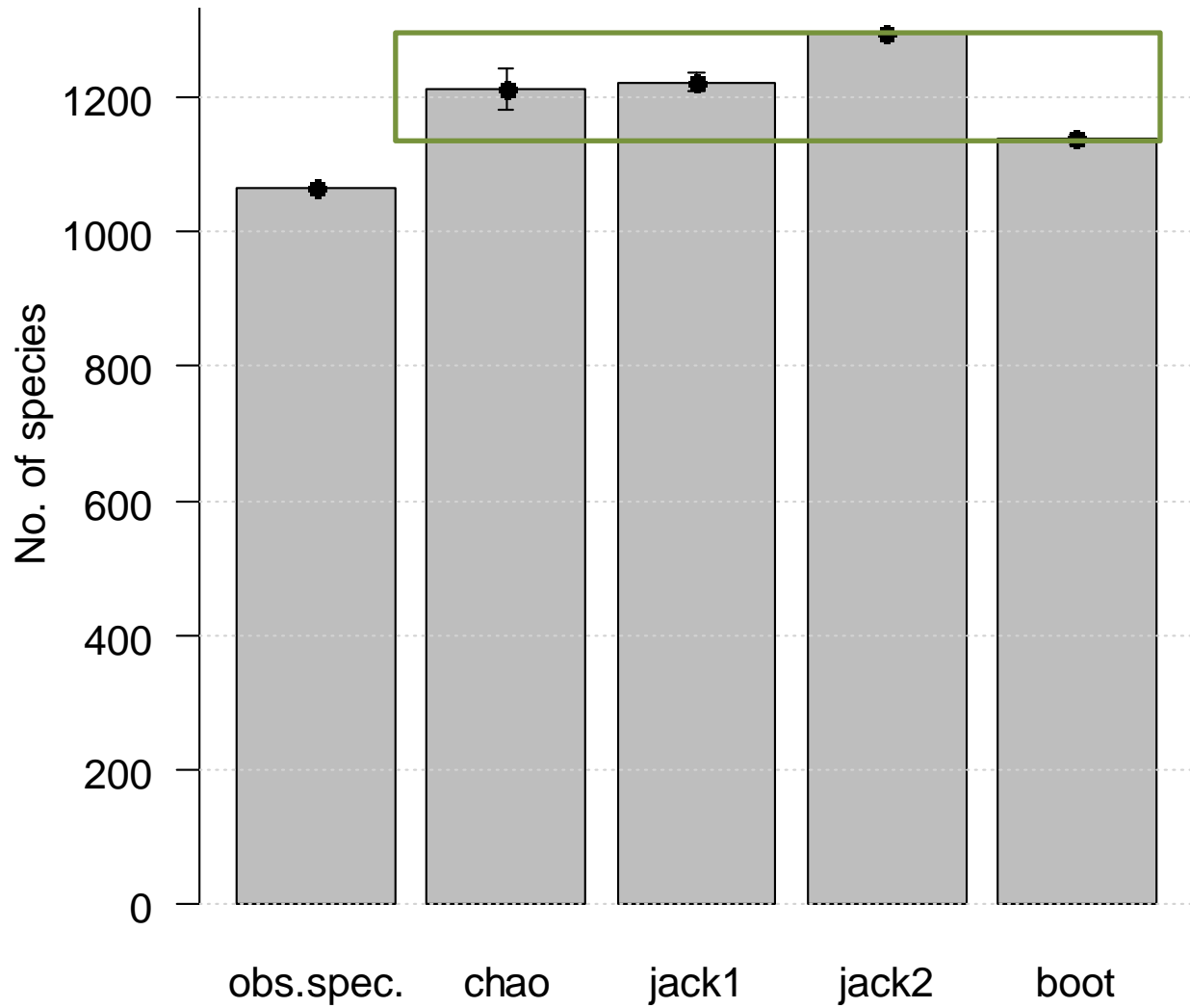


No. of vascular species in floodplains of Rhein, Main, Donau & Elbe

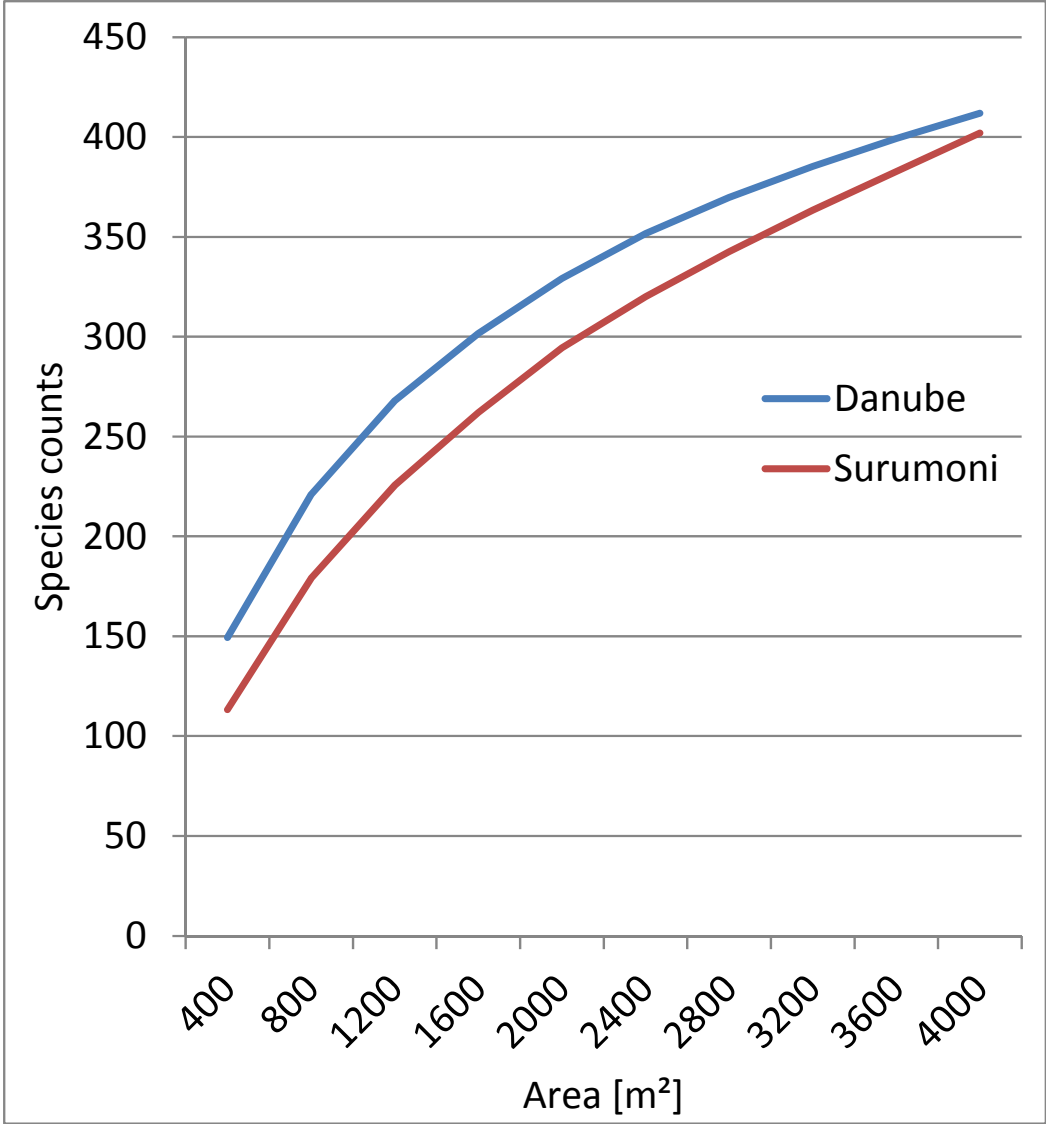


Rhine + Main + Danube + Elbe

1400 - 1066 counts → 1137 - 1295 estimated



Comparison of tropical vs German floodplain phytodiversity



sp./ha
Amazon 271*

Lima da Silva et al. (1992)

Danube 519

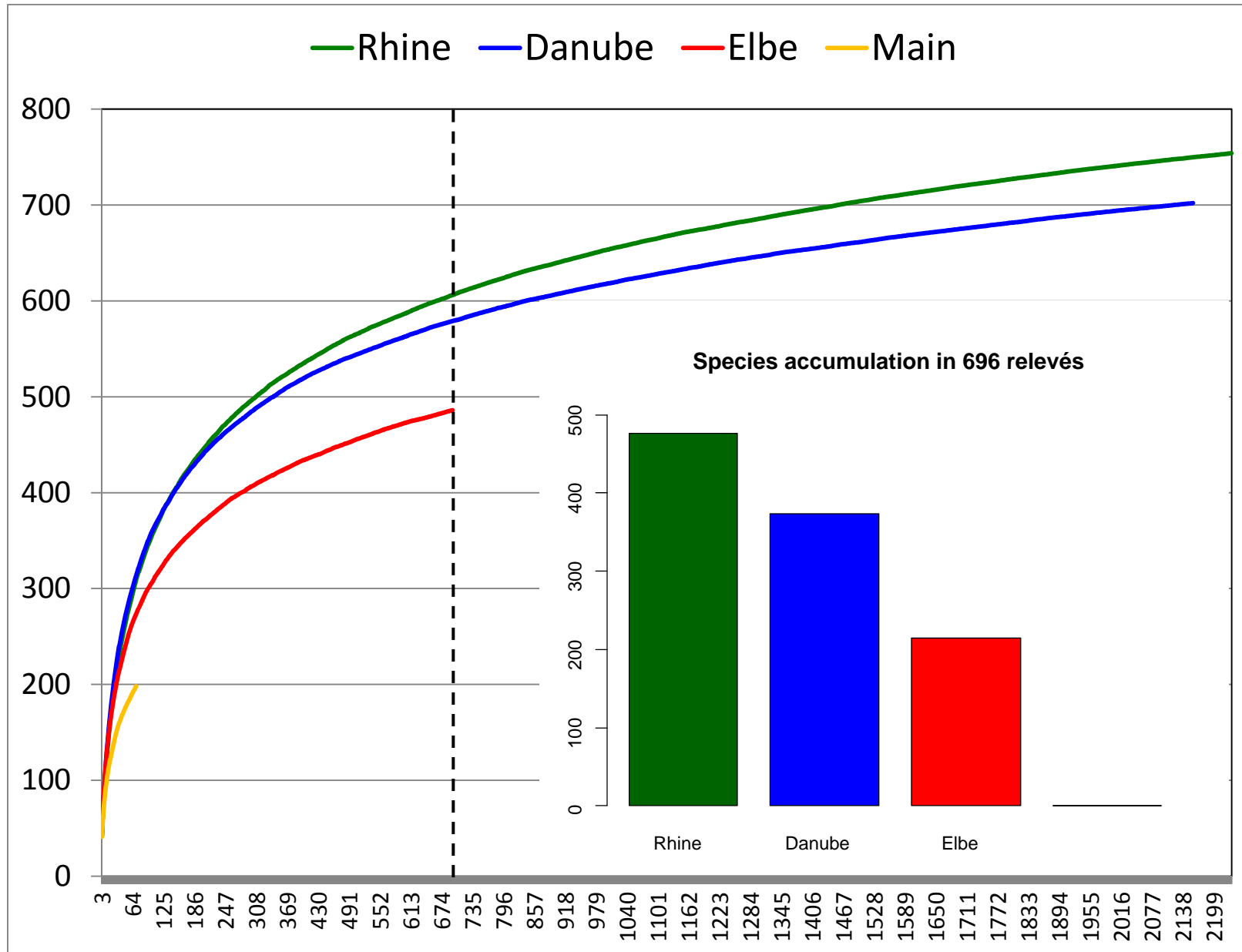
This study

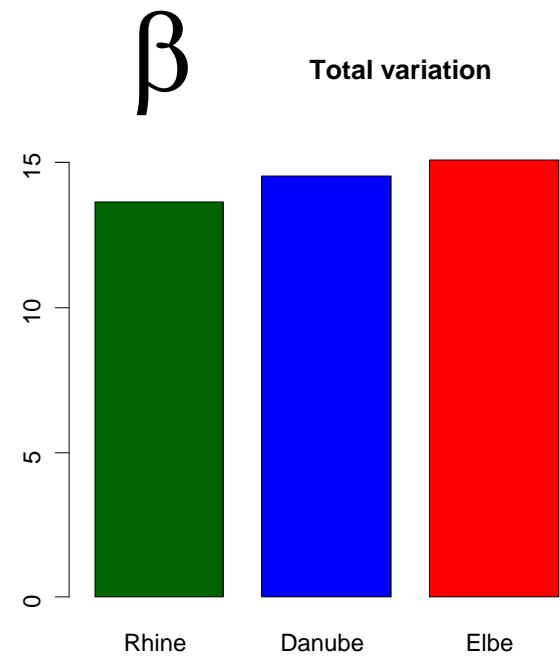
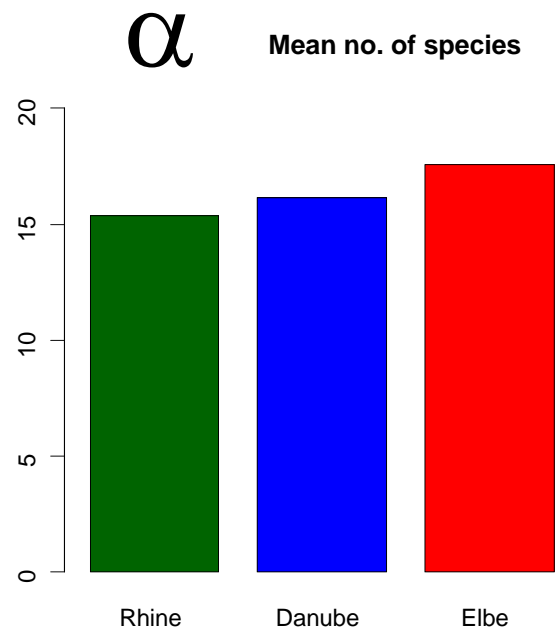
* Trees DBH ≥ 10 cm

≈ 35 - 50 % of total richn.

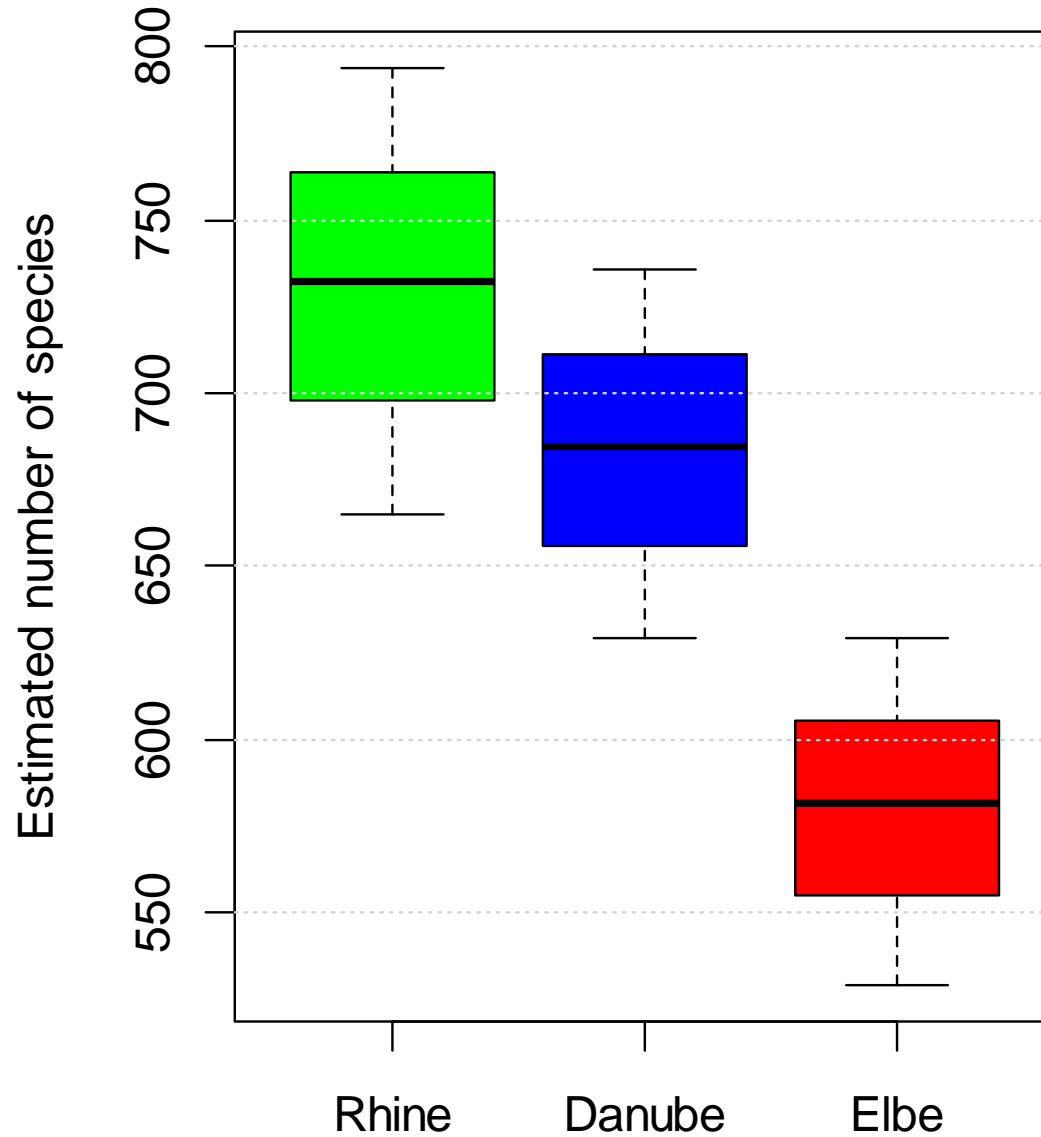
→ 543 – 774 species

Synopsis: all rivers





Estimates of species numbers at 696 relevés



Results

Vegetation types

Noise Clustering → 7 meaningful clusters

Alopecurus.Elymus	
	stat
Alopecurus.pratensis	0.62 **
Poa.trivialis.trivialis	0.56 **
Elymus.repens	0.55 **
Ranunculus.repens	0.53 **
Taraxacum.off.agg.	0.53 **
Rumex.crispus	0.34 **
Trifolium.repens	0.33 **
Agrostis.stolonifera.agg.	0.33 **

Iris.Lythrum	
	stat
Iris.pseudacorus	0.69 **
Galium.palustre	0.63 **
Lythrum.salicaria	0.61 **
Lysimachia.vulgaris	0.59 **
Carex.acuta	0.56 **

Urtica.Calystegia	
	stat
Urtica.dioica	0.53 **
Calystegia.sepium	0.52 **
Galium.aparine.agg.	0.51 **
Salix.alba	0.36 **
Impatiens.glandulifera	0.35 **
Humulus.lupulus	0.33 **

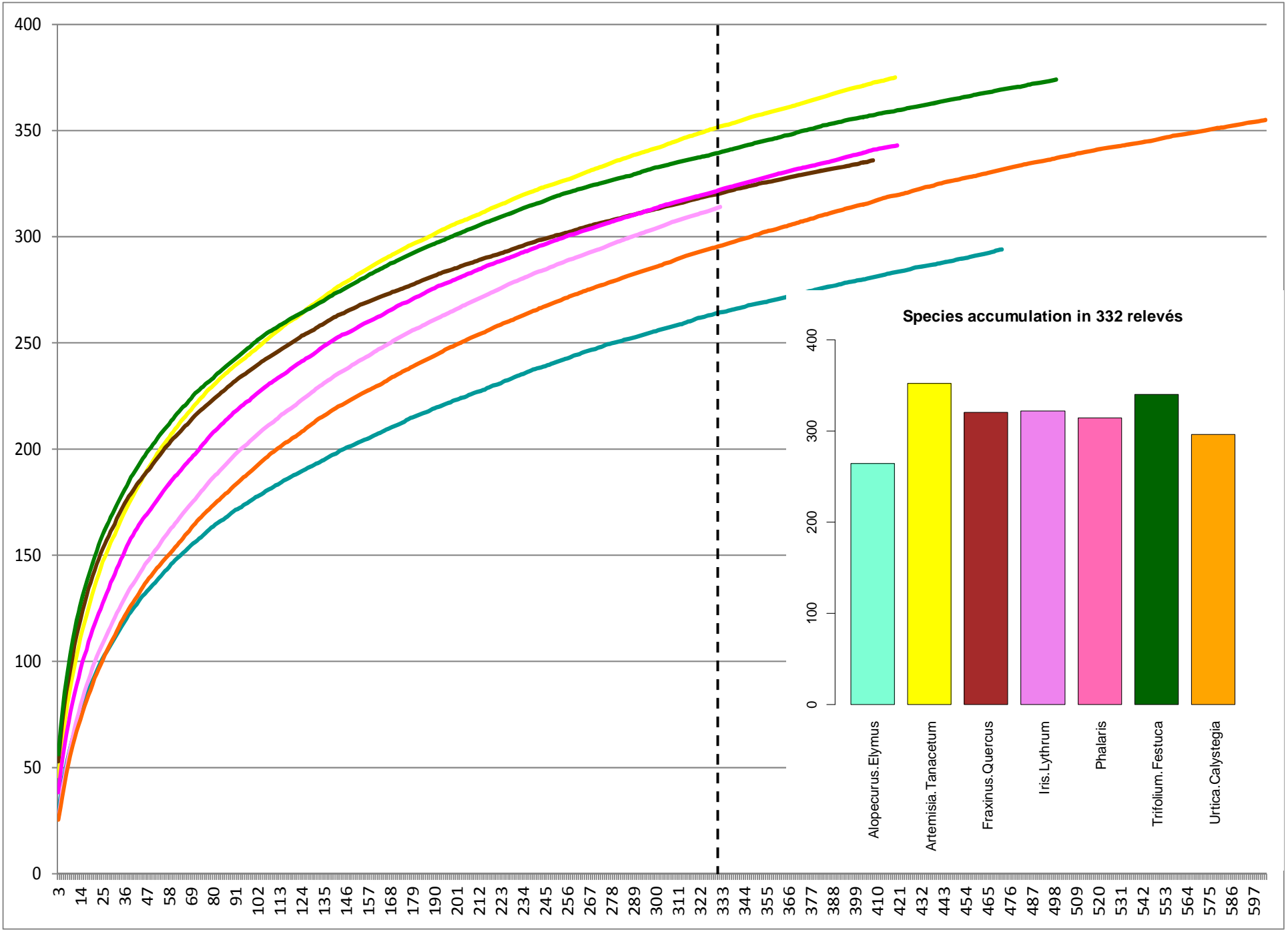
Trifolium.Festuca	
	stat
Trifolium.pratense	0.67 **
Ranunculus.acris	0.66 **
Plantago.lanceolata	0.64 **
Dactylis.glomerata.agg.	0.62 **
Festuca.pratensis	0.60 **
Lathyrus.pratensis	0.59 **
Galium.mollugo.agg.	0.58 **
Poa.pratensis	0.56 **
Achillea.millefolium.agg.	0.54 **
Arrhenatherum.elatius	0.53 **
Sanguisorba.officinalis	0.53 **

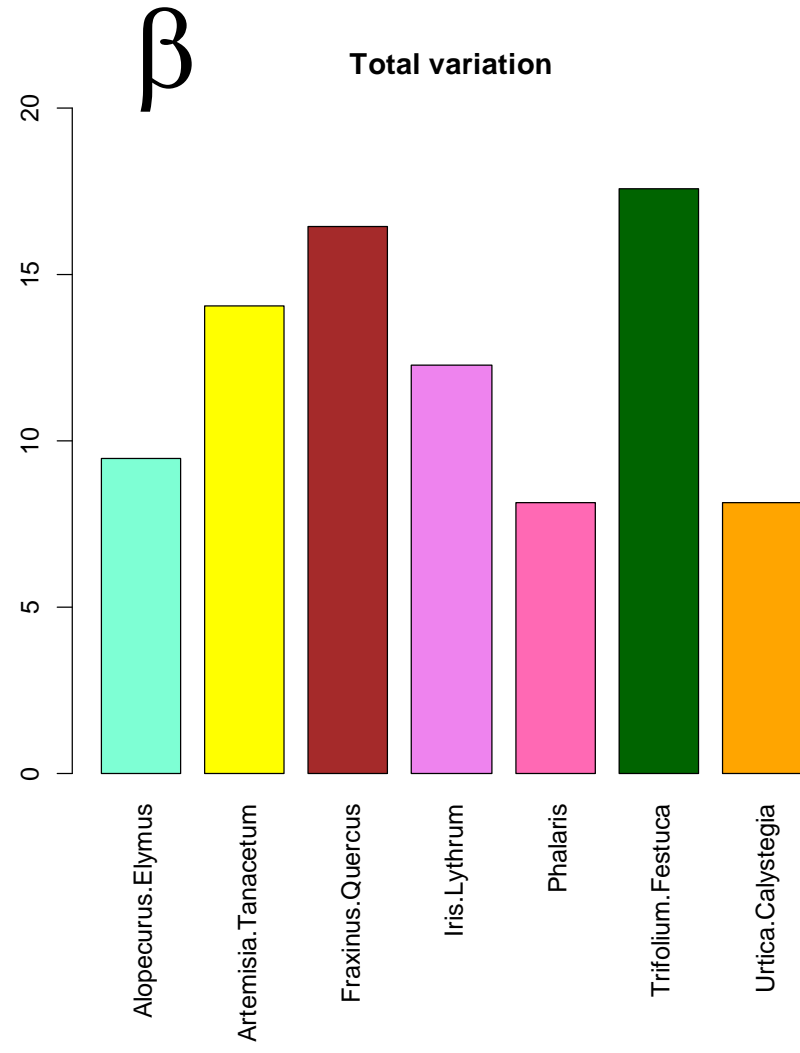
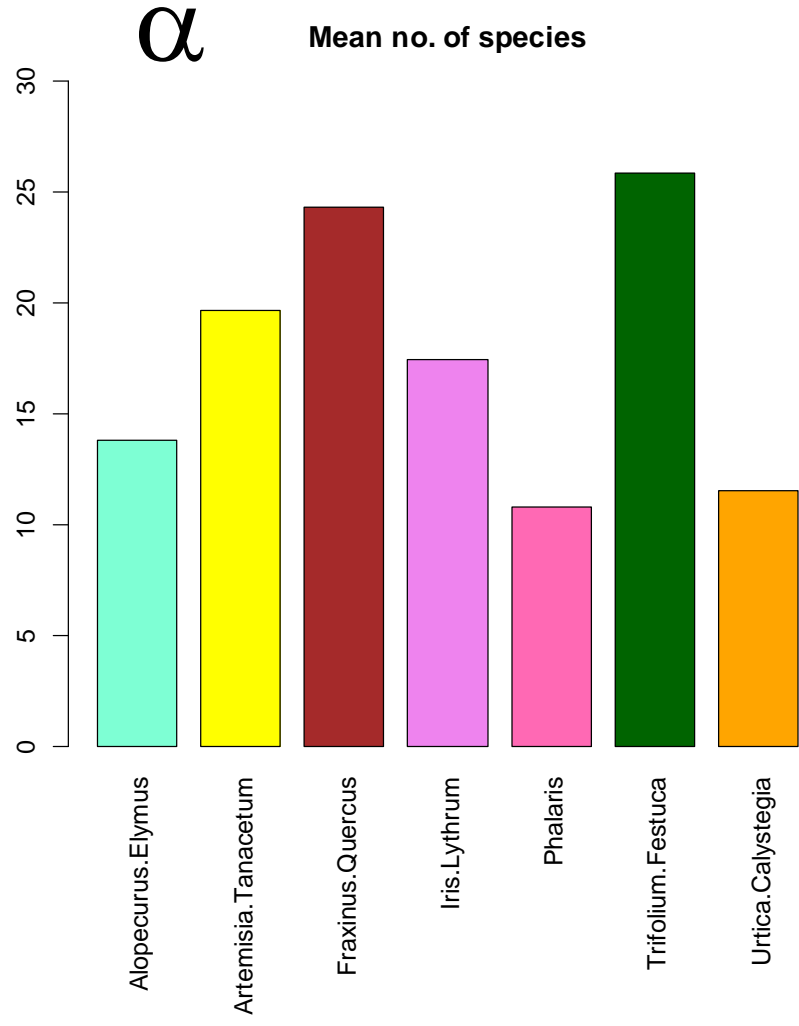
Phalaris	
	stat
Phalaris.arundinacea	0.51 **
Persicaria.hydro Piper	0.34 **
Bidens.froncosa	0.29 **
Rorippa.amphibia	0.28 **
Persicaria.lapathifolia	0.25 **
Rorippa.sylvestris	0.25 **

Artemisia.Tanacetum	
	stat
Artemisia.vulgaris.agg.	0.81 **
Tanacetum.vulgare	0.71 **
Festuca.arundinacea	0.63 **
Solidago.gigantea	0.59 **
Achillea.ptarmica	0.52 **
Rubus.caesius	0.47 **

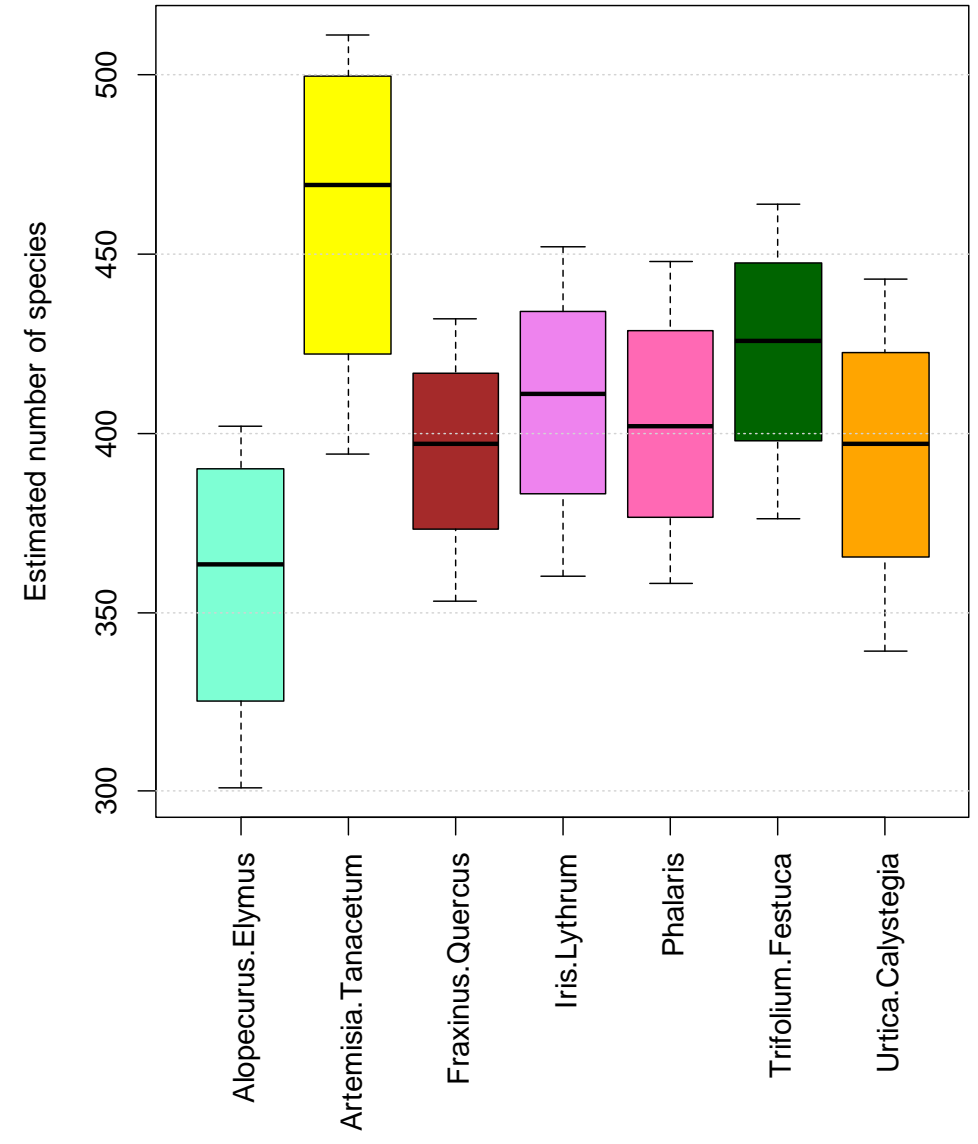
Fraxinus.Quercus	
	stat
Circaea.lutetiana	0.78 **
Fraxinus.excelsior	0.77 **
Brachypodium.sylvaticum	0.72 **
Carex.sylvatica	0.70 **
Quercus.robur	0.69 **
Geum.urbanum	0.68 **
Cornus.sanguinea	0.67 **
Stachys.sylvatica	0.64 **
Ulmus.minor	0.63 **

NC: rather small clusters (here 300 – 600 relevés)
 And one big noise cluster (here ca. 2000 relevés)





Estimates of species numbers at 332relevés



Discussion

- Floodplains are indeed rich in vascular plant species at the gamma level ($\approx 28\%$ of German species)
- Total species richness: Rhine > Danube >> Elbe
- High alpha div: hardwood forests and grasslands
- High gamma div: ruderal sites and grasslands
- However:
 - Data are biased and may lead to „false“ results (e.g. river pioneer sampling at the lower Rhine)
 - Area coverage is bad for the Danube (70 km)
 - Vegetation type coverage is bad for the Elbe (mostly grassland relevés)
 - Vegetation type coverage is unbalanced for the Rhine (few forest relevés at the lower Rhine few grassland relevés at upper Rhine)

Many thanks to:

- The contributors of data
- Florian Jansen (vegdata)
- Miquel de Cáceres (vegclust)

A photograph of a river with a large log jam and dense forest. The river is filled with water and has a large log jam in the foreground. The background is a dense forest of green trees. The text "Questions...?" is overlaid on the image.

Questions...?