

Longitudinal patterns of fish diversity and spatial distribution along the river gradient

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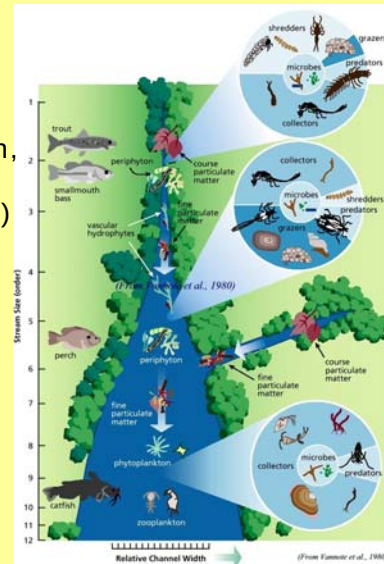
eawag
aquatic research

The River Continuum Concept Vannote et al. 1980

Linear and continuous change of:

- physical conditions (e.g. light)
- processes (production and respiration, input of organic material)
- morphology (channel width, gradient)

⇒ Predictable pattern of assemblage structure:
Aquatic communities are composed according to habitat and food type (trophic guilds)



The River Network Hypothesis Benda et al. 2004

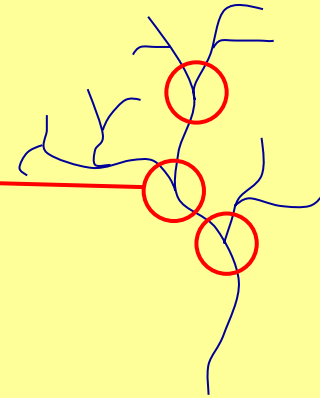
Hierarchical and branching **network** of channels and their confluences:

Abrupt changing water and sediment flux

⇒ **Tributary confluence effects**

- gradient (steepening/lowering)
- sediment/debris deposition
- substrat composition
- channel formation/morphology

Network geometry has consequences on habitat heterogeneity, therefore for biological diversity and productivity!



Longitudinal fish distribution patterns and local assemblage composition

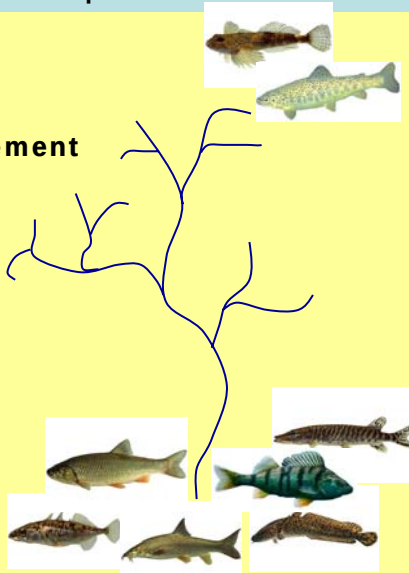
Faunal transition

-> **species addition or replacement**

Watershed scale:
land-use features
(agriculture, urbanization)

Reach scale:
hydrophysiological and
geomorphic factors

Subunit scale:
channel units,
mesohabitats



Environmental gradients that have been shown to influence fish distribution patterns

Hydrophysical and geomorphic habitat parameters:

- Gradient
- Channel depth/width
- Substrat
- Watertemperature
- Current velocity
- Chemical parameters (pH, oxigen, conductivity...)

Also: migration barriers



Aim: overview on longitudinal diversity patterns and structural composition

Questions: which is/are...

- Local environmental **key variables** that are associated with community structure in Swiss rivers?
- Factors causing **gradual or abrupt changes** in assemblage structure? Do the parameter gradients consist with the **faunal gradient**?
- Influence of **temperature-heterogeneity** on species distribution and diversity? (tributary effects, side channels)
- Fish species that cause essential **compositional shifts**?
- Species/guild-specific habitat use and **ecological niches**?
- Role of tributaries and **longitudinal connectivity** for species diversity?

Method: hierarchical approach- nested sampling

- 2-3 small to medium sized midland river
- Including 1 river south of the Alps (Sense, Brenno...?)
- Preferably floodplain; not heavily modified
- Fieldwork: May-October (3 weeks continuously per river)

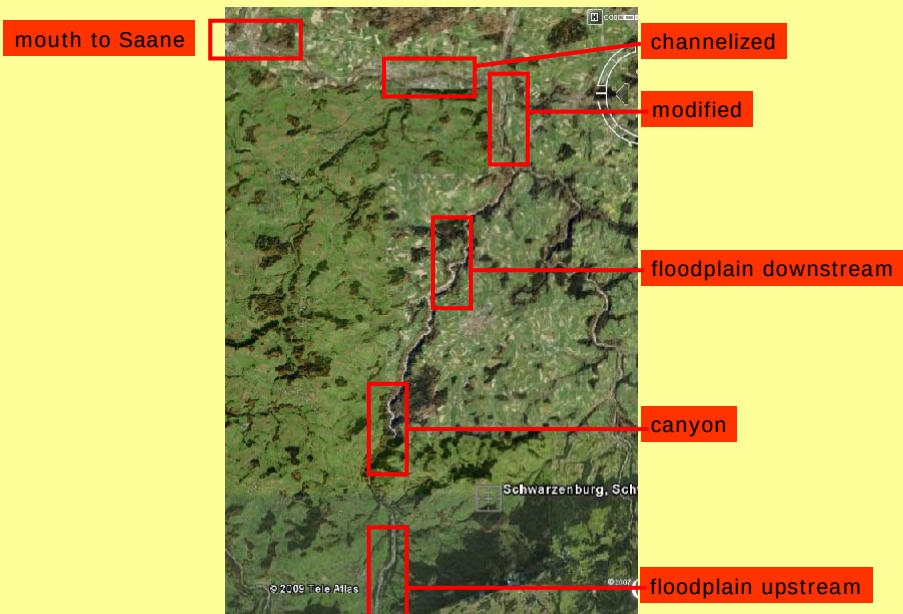
Reach-sampling:

- large-scale overview
- along selected, morphological homogenous river stretches
- length of reaches: 100m
- single pass, no block nets
- both shorelines, mid-channel

Point-abundance sampling: ●

- low effort, large # of closely spaced random samples
- closer focus at units of high habitat heterogeneity (side channels, transversal gradient)
- high resolution of assemblage alteration
- 1-2m sampling radius

For example: Sense river -> different channel-type segments



Within each segment: selected sampling reaches



modified



Within each segment: some sampling reaches



floodplain

Hydrosystem channel types:

- Main stem
- Surface connected channels
- Alluvial channels (no surface-upstream source)
- Isolated pools
- Tributary streams



Focus sampling sites



- Tributary confluences
- Below/above barriers

=>The role of connectivity and tributaries for species diversity!

Fish data

Assemblage Characteristic:	Parameter:	qualitative (area/reach)	point-abundance (sample-radius)
Species richness	# of species	X	X
Diversity	Hs, β , γ	X	X
Relative abundance	# of individuals, frequency of occurrence at sites/habitats (presence/absence %)	X	X
Structural composition	proportion of each species (%), dominance	X	X
Density	statistically estimated # of individuals	X	
Size classes	total length (mm)	X	X
Ecological guilds	frequency of rheo-/limnophil, eurytopic	X	X

Local environmental variables	
Morphologic/site characteristic:	Chemical:
Relative position within river	Conductivity
Length of river stretch sampled	Oxygen
Area sampled	Tot-P
Max. depth at site	(DOC)
Wetted bed width	(TOC)
Slope of segment/elevation (m a.s.l.) at site	(Suspended solids)
Channel morphology	pH
Barriers/connectivity	(Alkalinity)
Predominant substrate	NO ₃
Hydrophysical:	NO ₂
Water temperature	NH ₄
Mean profile current velocity (at 0.6 depth)	

Approaching the questions	
•Differences between sites of: -local diversity -assemblage structure (guilds) -proportion of guilds -habitat features	similarity tests, correlation/regression analysis
•Longitudinal patterns: -abrupt or regular change of species richness -diversity hot spots -faunistic shifts	spatial autocorrelation (position within the river) correspondance analysis (CCA, DCA, FCA)
•Identifying key habitat variables for specific species/guilds	PCA