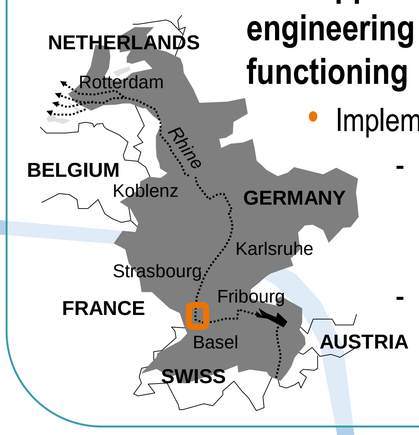
I.S.RIVERS LYON 2018

Controlled bank erosion and implementation of transverse artificial groynes: responses of biological communities (Upper Rhine, France)

Erosion maîtrisée avec implantation d'épis transversaux artificiels : réponses des communautés biologiques (Rhin Supérieur, France)

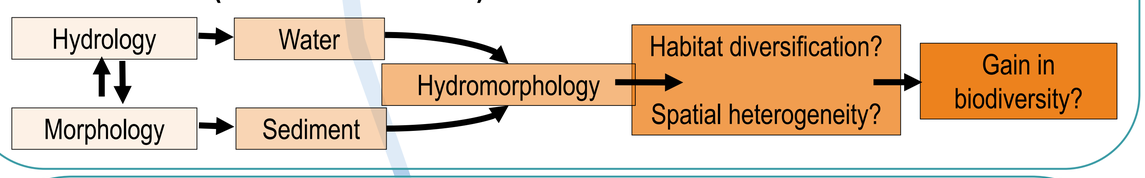
Historical events

- **The Upper Rhine River was subjected to important hydraulic engineering works which have severely damaged its functioning**
  - Implementation in April-May 2013 of:
    - Lateral controlled bank erosion
      - » Increase the lateral mobility
      - » Favor alluvial landscape and pioneer plant species
    - In-channel transverse artificial groyne implementation (x 2)
      - » Favor flood action to create a continuous sediment feeding



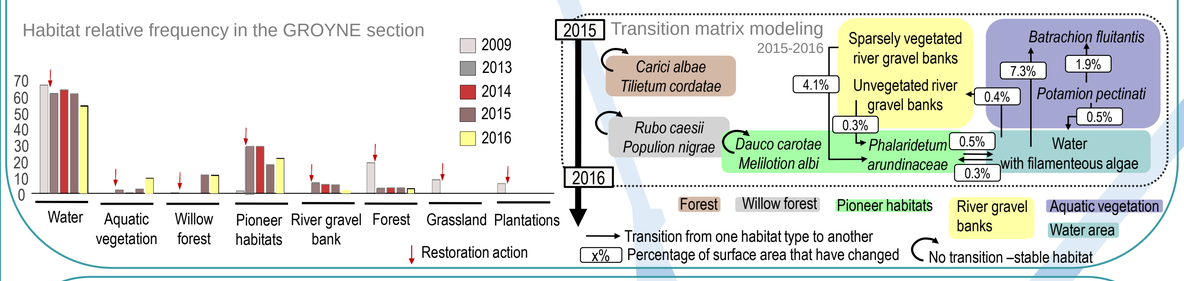
Objectives of the research

- **Investigate morphological and biological post-restoration changes**
- **Assess the sensibility of restored areas to invasive species (novel interactions)**



New metrics and approaches

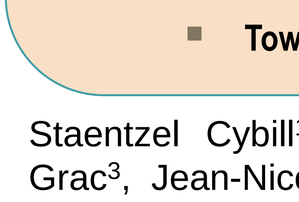
- **Quantification of change by the development of new metrics such as EHMID (Staentzel *et al.*, submitted) or PCI/ZCI metrics (Staentzel *et al.*, 2018a)**
- **Use of transition matrix modeling (Staentzel *et al.*, 2018a)**
  - Return of an alluvial landscape
  - 3-years post-restoration: increase in aquatic plant species



Habitat diversification

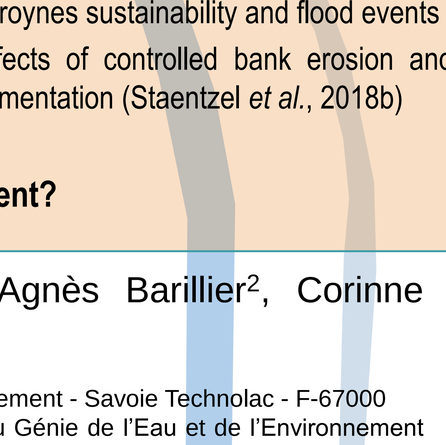
- **Gain in spatial heterogeneity at a fine scale (EHMID)**
  - Index based on the coefficient of variation: ratio of the standard deviation to the mean
  - Contribution of groynes: low velocity and fine substrate

Eco-HydroMorphological Index (EHMID)



D50: median diameter or the medium value of the particle size distribution

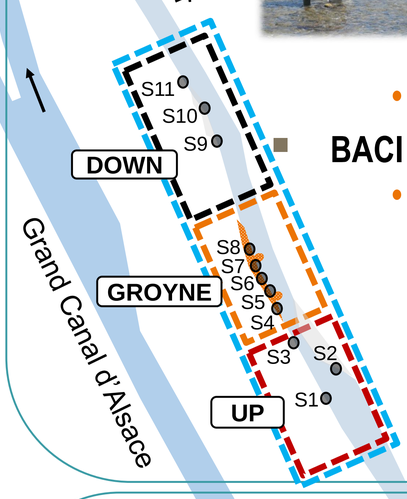
EHMID values for UP, GROYNE, DOWN, NOT RESTORED and GLOBAL SITE



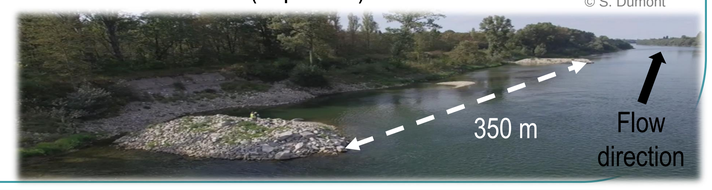
Methods and study design

- **Global ecological monitoring (2014-2017)**
  - Multi-compartments and interdisciplinary study
    - Aquatic and riparian vegetation: surveys and cartography Macroinvertebrates: sampling campaigns (eleven stations using the Hess sampler ; S1 to S11)
    - Electrofishing and Gobiidae catch
  - Link with geomorphology (Chardon *et al.*, 2018)

- **BACI protocol (Smith *et al.*, 1993)**
  - Three sections highlighted
    - Not restored (control): UP and DOWN
    - Restored section (impacted): GROYNE

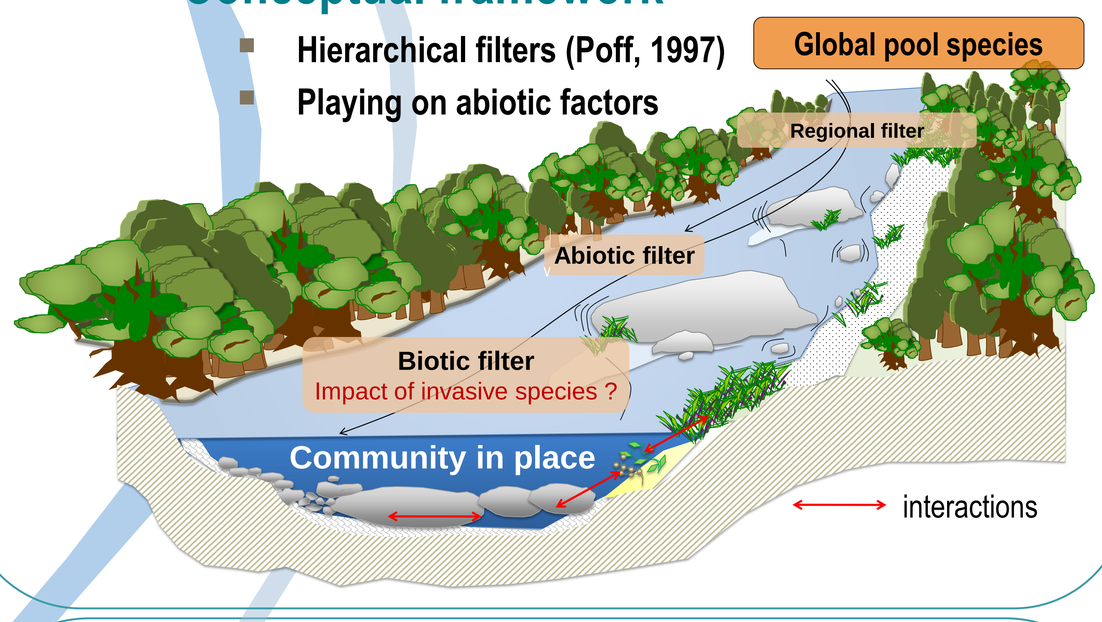


GROYNE section © S. Dumont



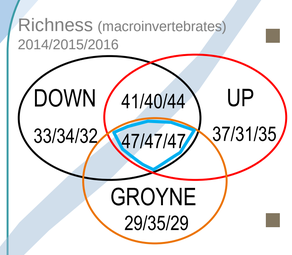
Conceptual framework

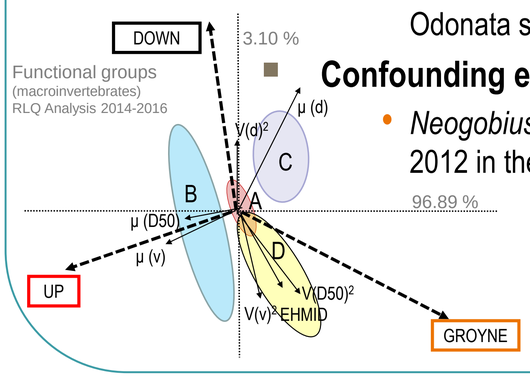
- **Hierarchical filters (Poff, 1997)**
- **Playing on abiotic factors**

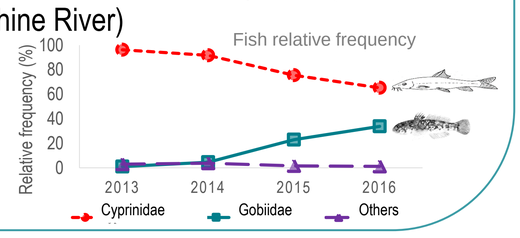


Structure and functionality

- **Structure and composition**
  - Gain in macroinvertebrate richness at the global site (*D.villosus*, invasive crustacean species dominance)
  - Coexistence of lentic and lotic aquatic plant profiles from 2016
- **Functionality**
  - New functional group: species adapted to fine substrate as Odonata species (group D)
- **Confounding effects : biotic interactions as predation?**
  - *Neogobius melanostomus*: invasive fish species (arrived in 2012 in the Upper Rhine River)

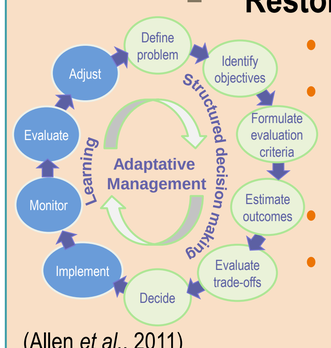






Conclusion and prospects

- **Restoration efficiency and durability?**
  - Low lateral bank erosion compared to attempts
  - High response of aquatic plant species three years post-restauration (Staentzel *et al.*, 2018a) and of young fish – Mitigated responses from macroinvertebrate communities
  - Biological effects depending of groynes sustainability and flood events
  - Stronger positive ecological effects of controlled bank erosion and groynes compared to gravel augmentation (Staentzel *et al.*, 2018b)

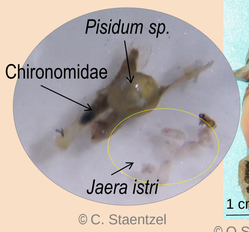


(Allen *et al.*, 2011)

- **Towards an adaptative management?**

- **Complementary studies**
  - *N. melanostomus* predatory effect: impact on the low trophic food level (macroinvertebrates) and large cannibalism
  - Comparison with other restored sites by gravel augmentation or implemented without in-channel transverse groynes
  - Link between invasive species and extrem flood events?

Gobiidae stomacal content



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