Microhabitats survey used in river restoration

A. Peeters, E. Hallot, G. Houbrechts, F. Petit

I. Framework

Pilot project « Walphy » - Design of a decision tool for hydromorphological restoration of water bodies in Walloon Region (LIFE07 ENV/B/000038)

- Co-funded by EU
- 5 years project, started in January 2009
- 3 partners:
  - Service Public de Wallonie, Unnavigable watercourse Dept., Namur
  - University of Namur, Research Unit in Environmental and Evolutive Biology
  - University of Liege, Laboratory of Hydrology and Fluvial Geomorphology
- Objectives:
  - Developing a structured approach aiming at improving hydromorphological quality of the upstream Meuse basin in order to achieve the “good ecological status” required by the WFD (2000/60/CE)
  - Development of a useful and suitable methodology in Walloon Region to determine and schedule river restoration works
  - Realisation of experimental and demonstrative river restoration works on several risk water bodies (“Bocq upstream”, “Bocq downstream” and “Eau Blanche downstream”)
  - Ecological and geomorpholigical monitoring of the restored river system

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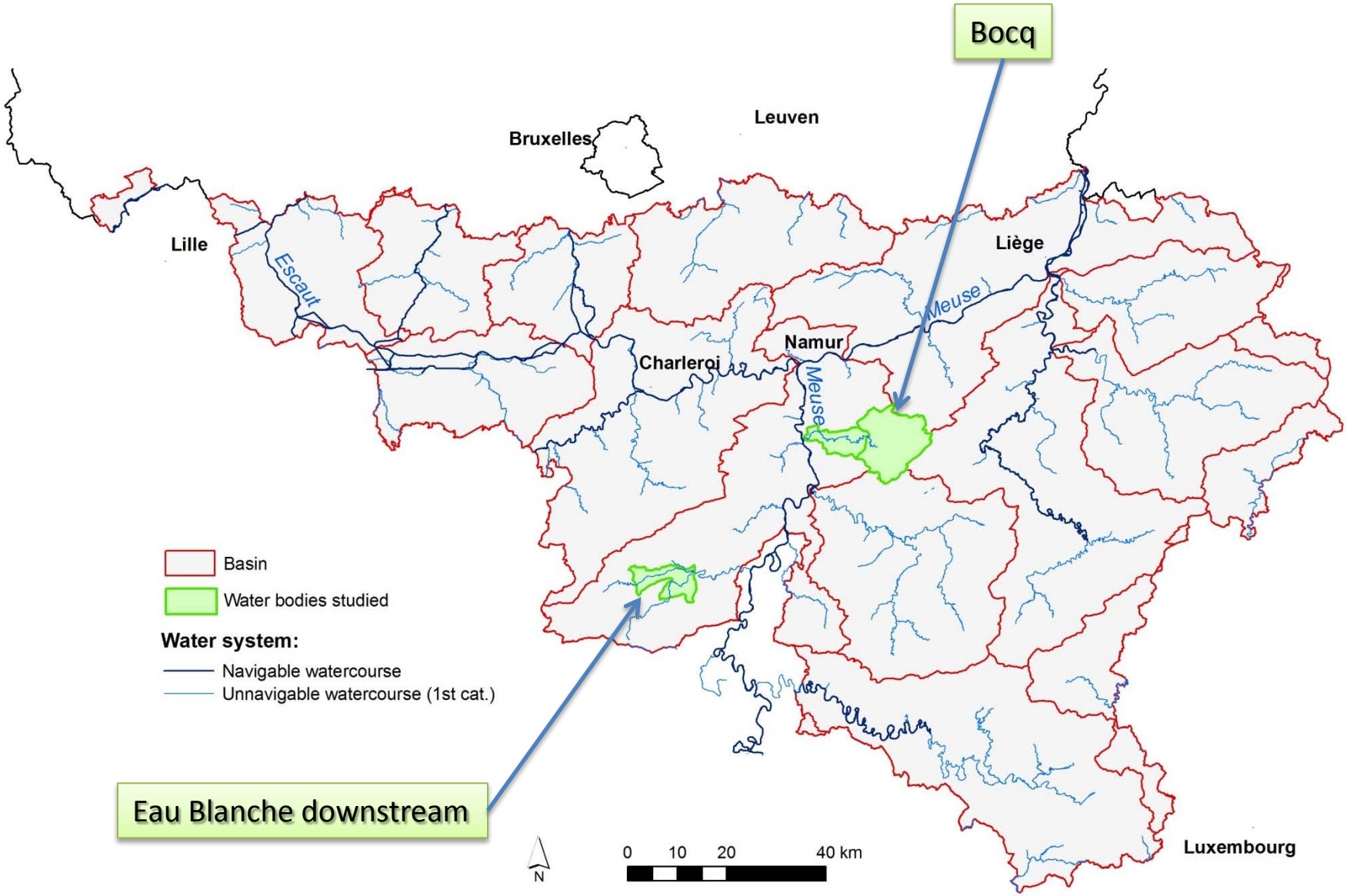


II. Definition and application

- **Definition**: A habitat is an ecological or environmental area that is inhabited by a particular species of animal, plant or other type of organism.

  The term microhabitat is used to describe the small-scale physical requirements of a particular organism or population (Abercrombie *et al.*, 1966).

  Exemple: *Cottus gobio* -> Habitat: River and stream

  -> Microhabitat: coarse substrata (gravel and cobbles), with high water velocity and shalllow depth

- **Applications of the microhabitats survey**:
  - Determining microhabitat preferences of organisms (fishes or macroinvertebrates)

    ➡ Development of hydraulic models -> tools to enable habitat predictions

  - Assessing the hydromorphological quality of a reach of a river (-> indexes)

    ➡ When comparing before/after river restoration works -> tool for assessing the success of the works

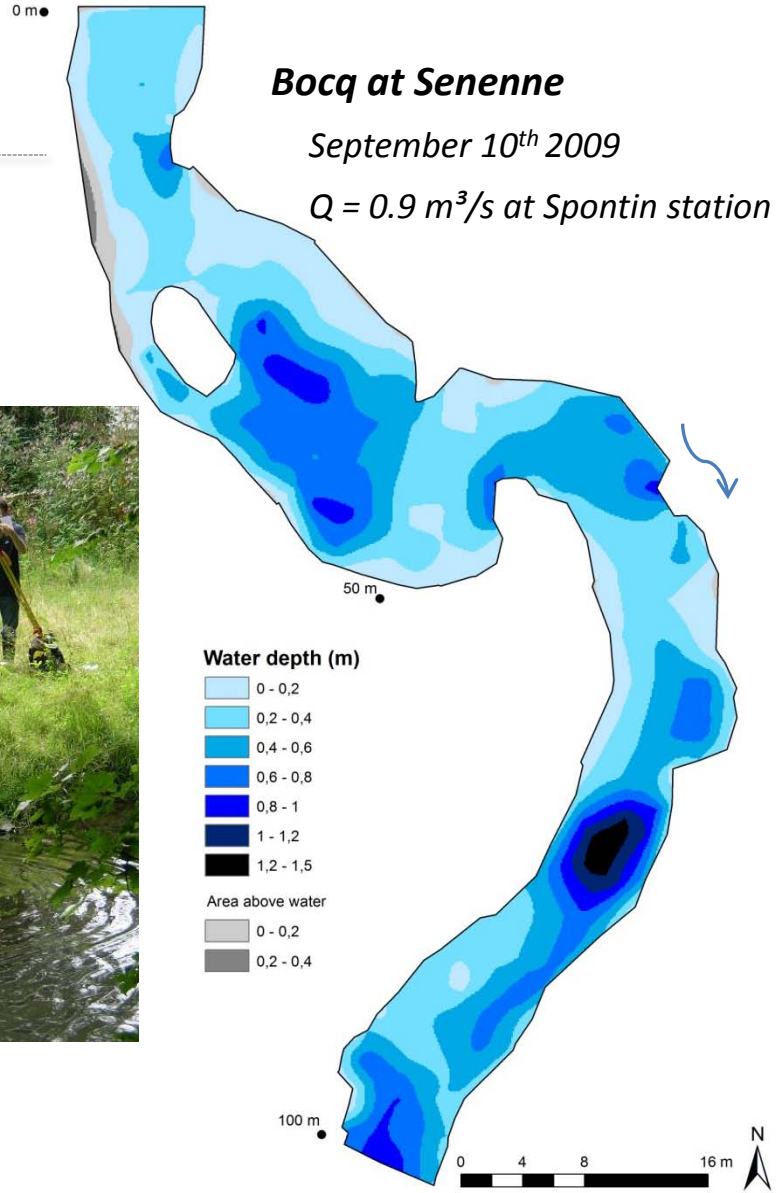
III. Methodology

3.1. Water depth

- Field survey of the stream channel:
  - Stream bed boundary
  - Stream bed elevation
  - Water surface elevation

- Interpolation
  - Stream bed DEM
  - Water surface DEM

- Water surface DEM - Stream bed DEM = ***Water depth model***



Bocq at Senenne

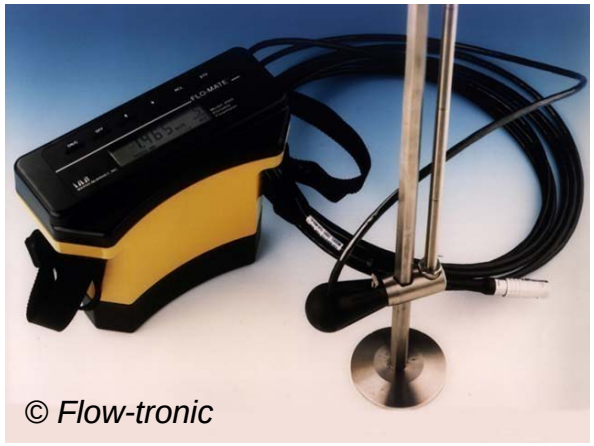
September 10th 2009

Q = 0.9 m³/s at Spontin station

III. Methodology

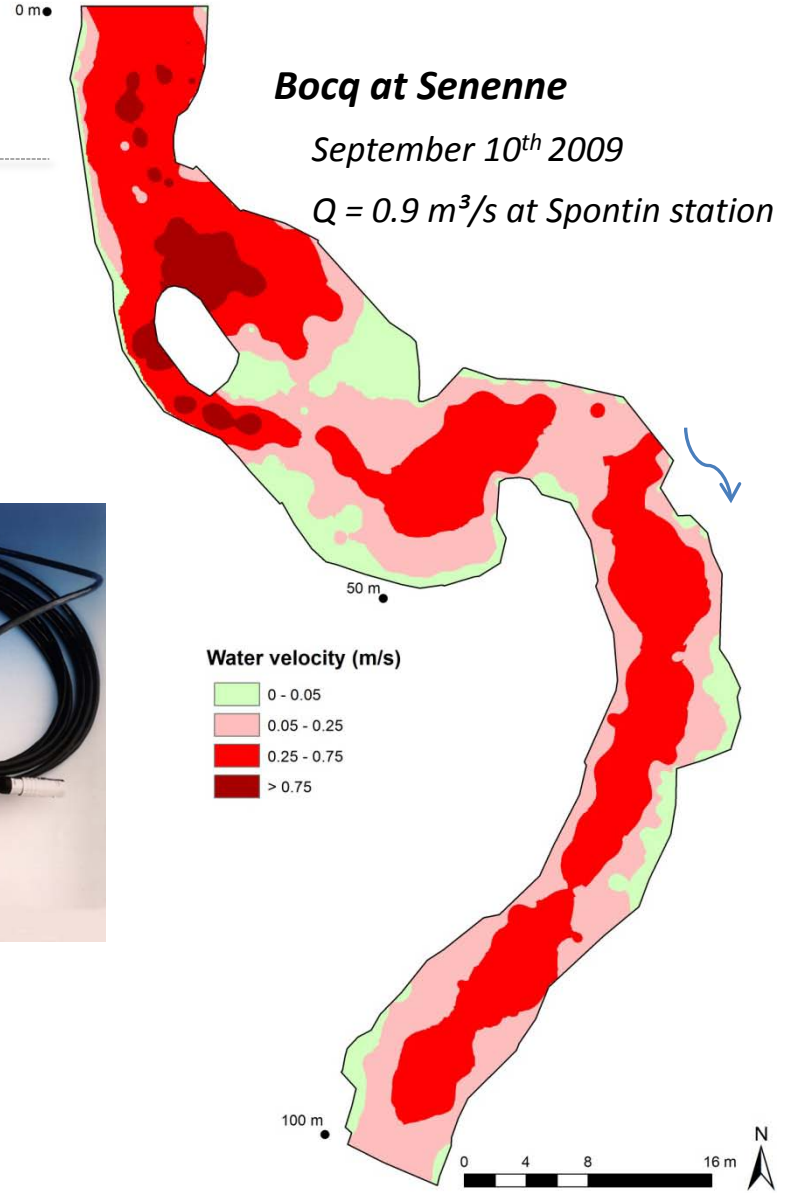
3.2. Water velocity

- Stream flow measuring:
  - « Randomly » located
  - With a water current meter (FLO-MATE Model 2000)


© Flow-tronic

- Interpolation

Water velocity model



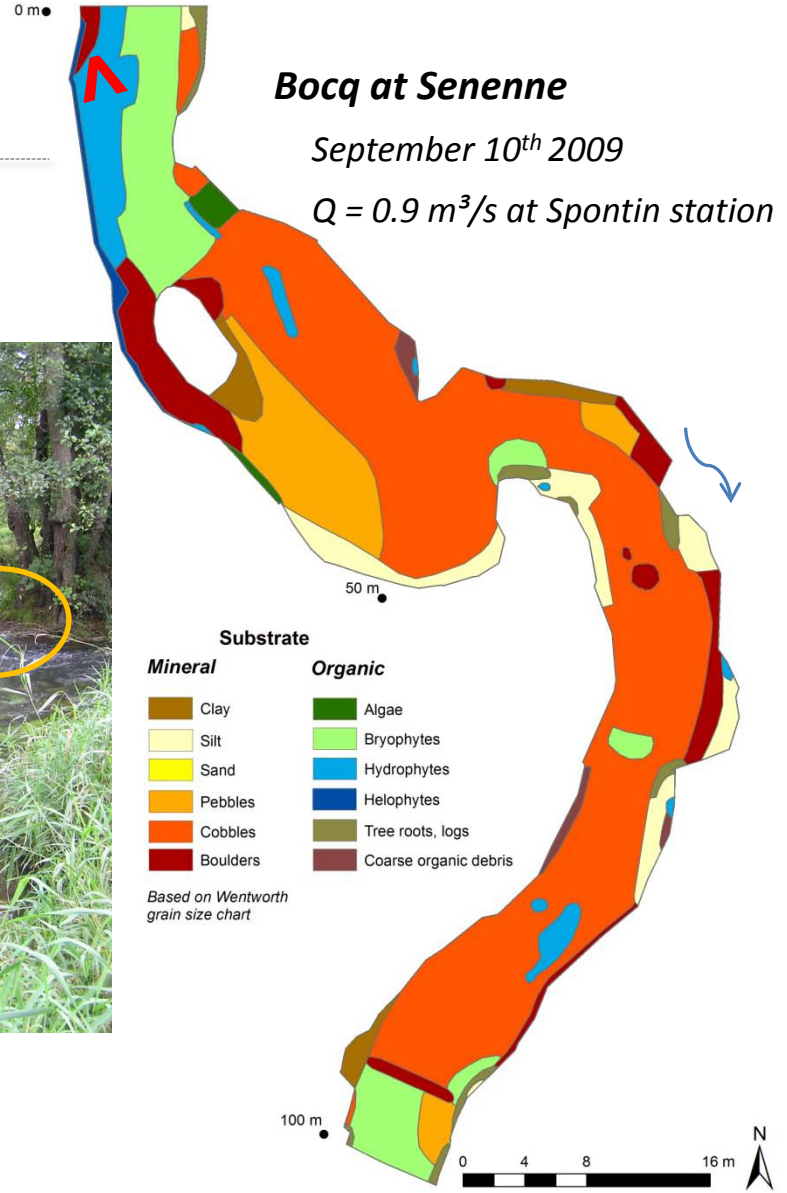
III. Methodology

3.3. Dominant substrate class

- Visually estimated

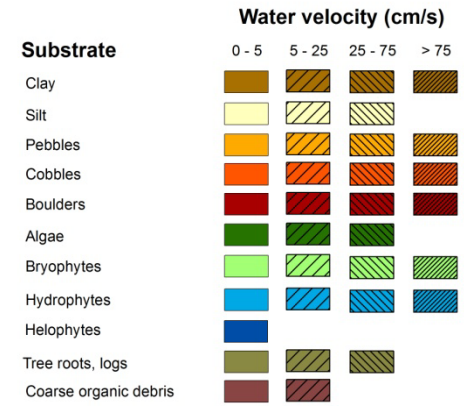
- Drawed on the field survey

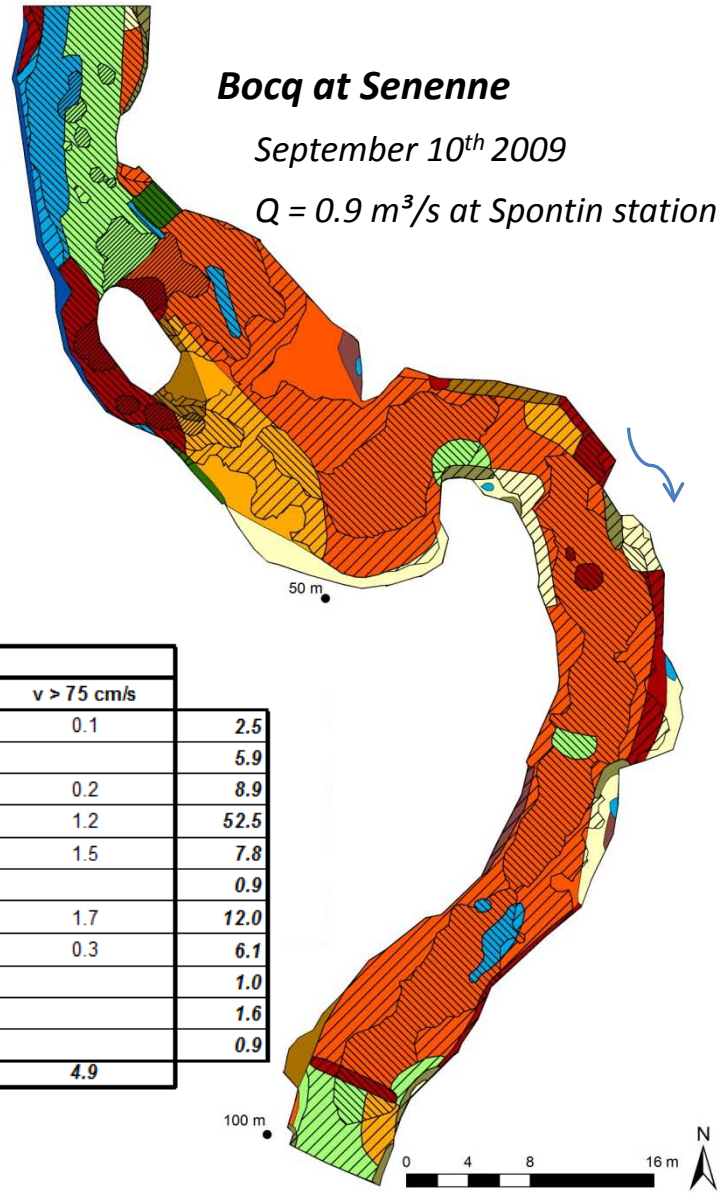
Dominant substrate class survey



III. Methodology

3.4. Microhabitat





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	Area (%)	WATER VELOCITY v < 5 cm/s	5 < v < 25 cm/s	25 < v < 75 cm/s	v > 75 cm/s	
SUBSTRATE	Clay	1.2	0.9	0.3	0.1	***2.5***
	Silt	3.5	2.1	0.3		***5.9***
	Pebbles	1.9	4.9	2.0	0.2	***8.9***
	Cobbles	3.3	19.9	28.2	1.2	***52.5***
	Boulders	0.6	2.2	3.6	1.5	***7.8***
	Algae	0.2	0.1	0.6		***0.9***
	Bryophytes	0.2	2.8	7.3	1.7	***12.0***
	Hydrophytes	0.2	1.0	4.6	0.3	***6.1***
	Helophytes	1.0				***1.0***
	Tree roots, logs	0.4	1.0	0.2		***1.6***
	Coarse organic debris	0.5	0.4			***0.9***
		12.8	***35.3***	***47.1***	***4.9***	

IV. Applications for assessing effects of river restoration works

Microhabitats survey

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Tool for assessing hydromorphological quality of a reach of a river

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Tool for assessing the success of river restoration works

How ?

By comparing surveys and indexes made before and after the works

4.1. Characterizing fish habitat preference (indexes)

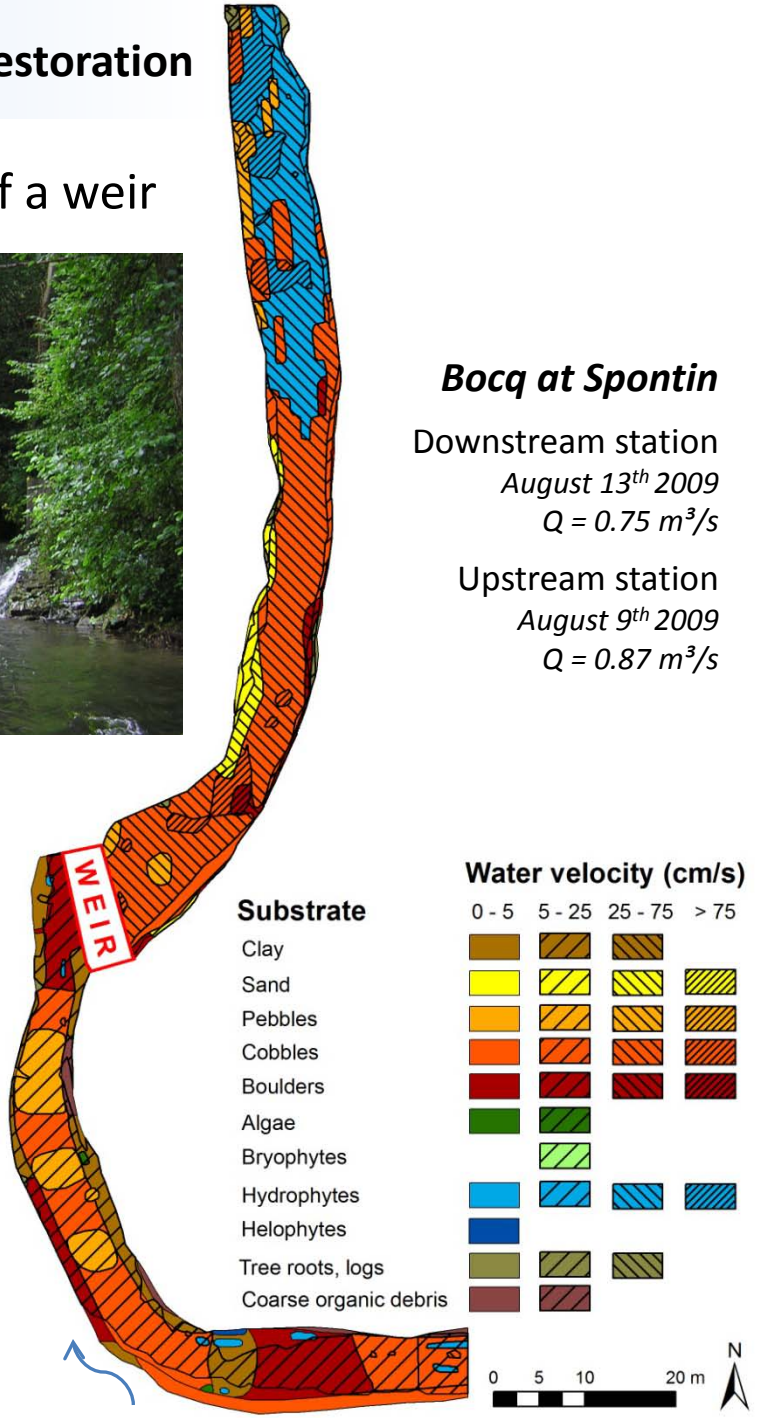
4.2. Basis for sampling benthic macroinvertebrates and for calculating several indexes

4.3. Basis for calculating hydromorphological quality indexes

Exemple of river restoration works: removal of a weir

Why?

- Free movement of fishes and sediments
- Decrease the flood impact (upstream)
- Enhancement of the hydromorphology (upstream)



Bocq at Spontin

Downstream station
August 13th 2009
Q = 0.75 m³/s

Upstream station
August 9th 2009
Q = 0.87 m³/s

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4.1. Fish habitat

- Electrofishing

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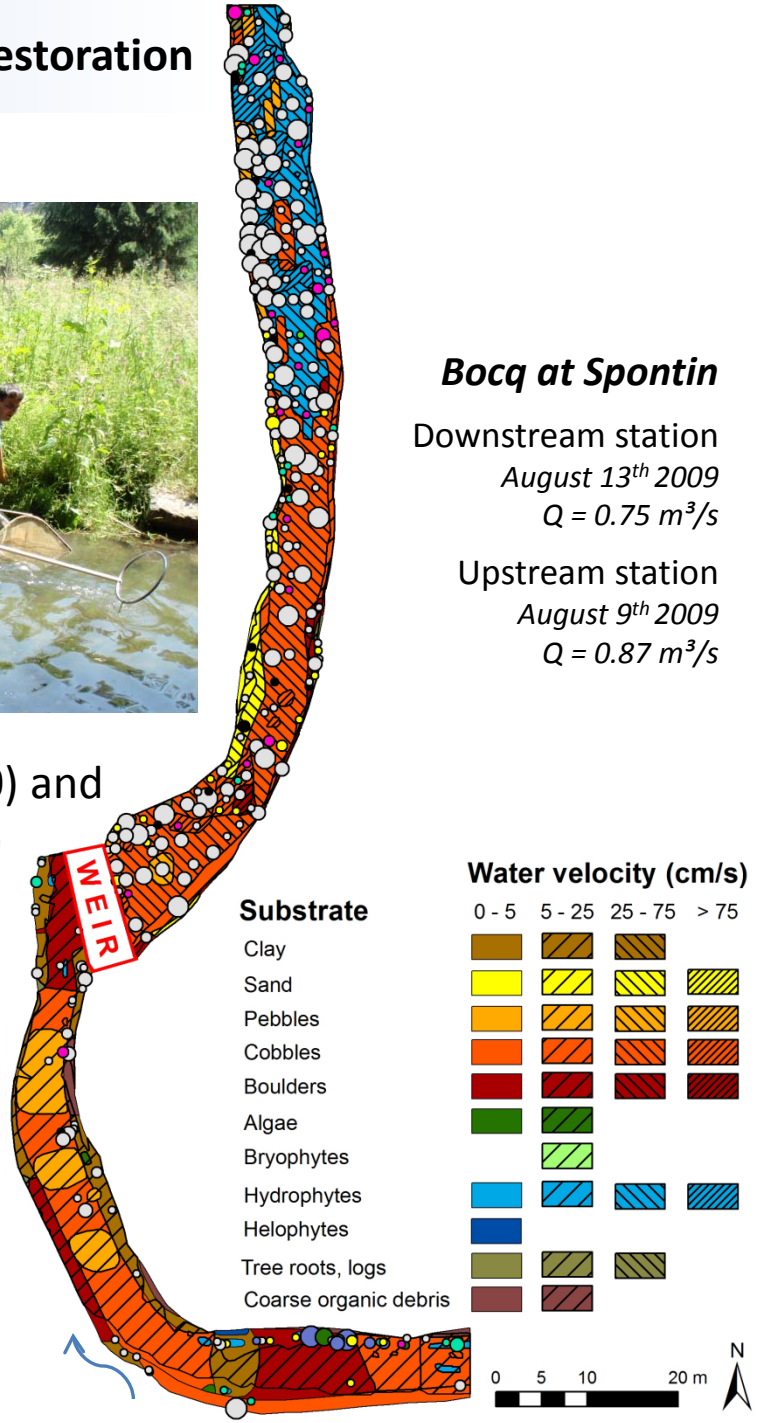
Survey of the fish populations:

- Abundance
- Density
- Species composition

- Comparison between downstream (24/30) and upstream (19/30) stations (Fish index IBIP)
- Linking fish location and microhabitat

June 22nd 2010 Q = 0.22 m³/s



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Downstream station
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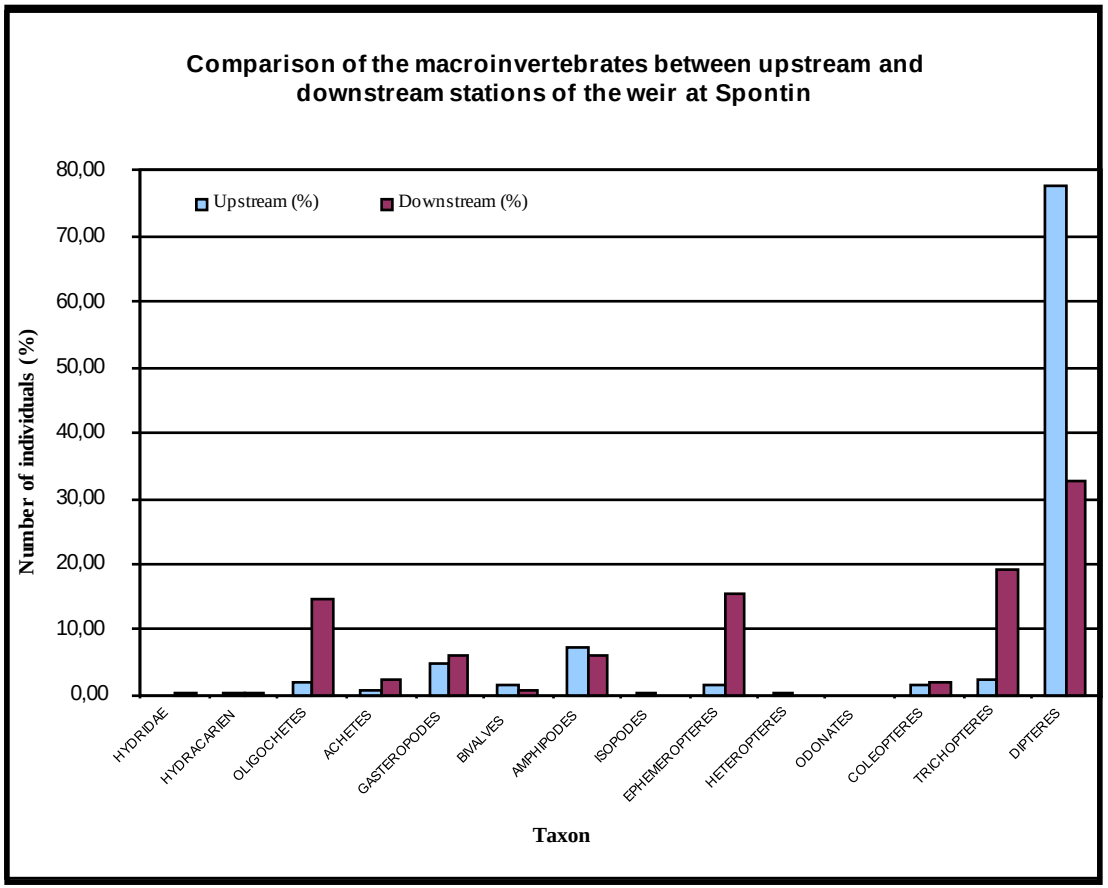
4.2. Benthic macroinvertebrates

- Microhabitat survey ➡ basis for sampling benthic macroinvertebrates and for calculating several indexes based on:
  - Abundance
  - Diversity
  - Species richness

- Biodiversity analysis



4.3. Hydromorphological quality indexes

e.g.: Morphodynamic attractivity index (IAM – Teleos, 1999)

Assessing the microhabitat diversity (substrate, water depth and water velocity)
➡ provide fish habitat predictions

$$IAM_{calculated} = \left(\sum_{1}^{n} (Si * Attract.(subs.) \right) * Var(subs.) * Var(he) * Var(v)$$

Si *= Area of the i substrate*
Attract. *= attractivity of the i substrate for the fish*
n *= Number of substrate*
Var(subs.) *= Number of substrate*
Var(he) *= Number of depth class*
Var(v) *= Number of water velocity class*

Substrate	Attractivity
Root wads, woody coarse debris	100
Undercut banks	90
Hydrophytes	80
Boulders (with fish caches)	60
Cobbles	50
Helophytes	40
Root mats	40
Boulders (without fish caches)	30
Mix of pebbles and cobbles	25
Pebbles	20
Organic debris	10
Sands	8
Clay and silt	4
Mud	3
Concrete surface and slab	1
Affluents, spring	+25%

"IAM calculated" compared to "IAM reference"

Bocq – Spontin downstream: 6022/8648 -> 70 %
Bocq – Spontin upstream: 1910/8600 -> 22 %

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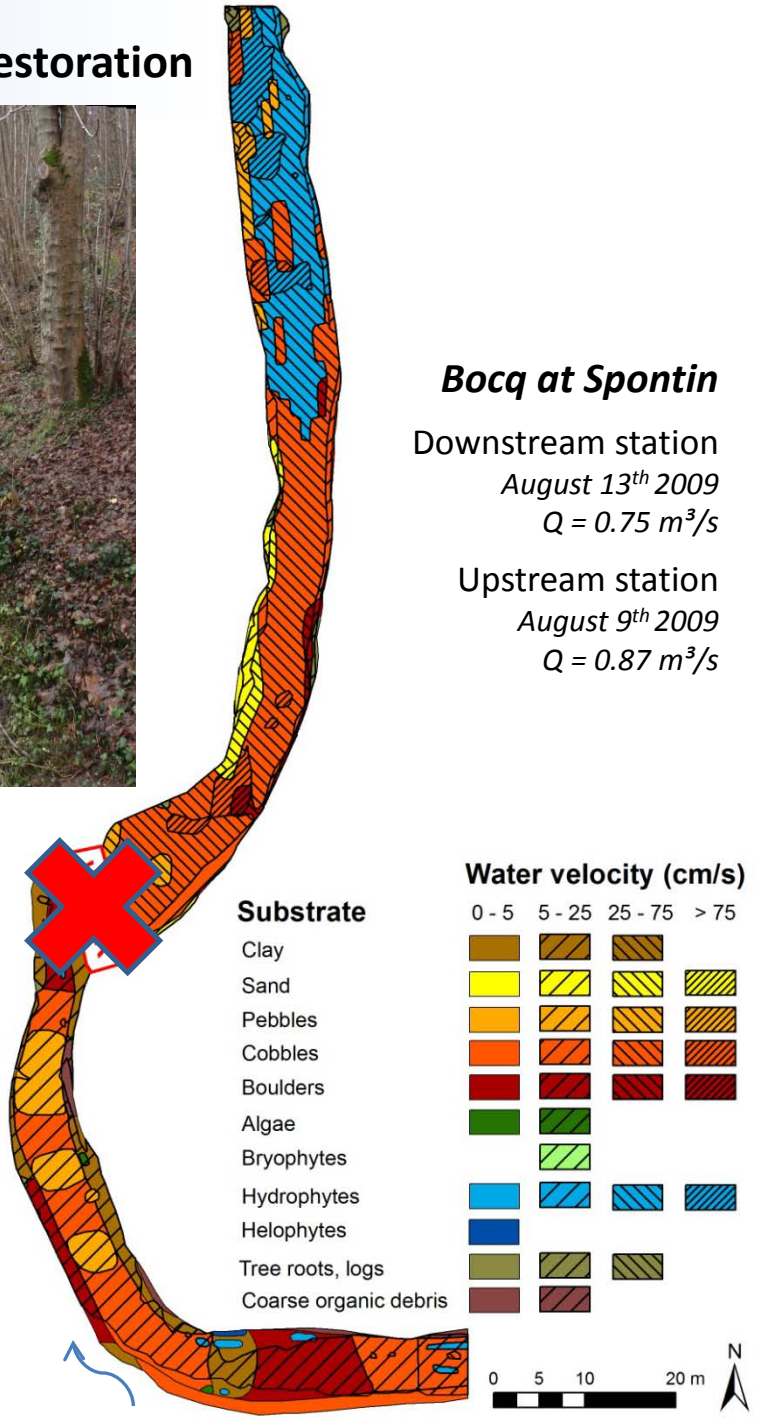
Removal of the weir (2010)



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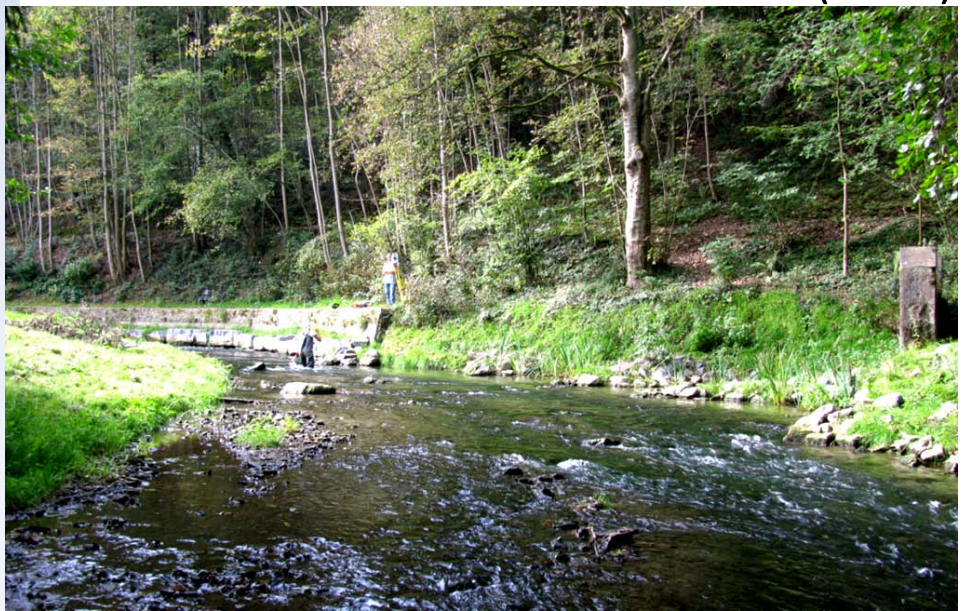
Before removal (2009)

Before removal (2009)

After removal (2011)



After removal (2011)

Monitoring after the removal:

- Survey of the new microhabitats (2012, 2014,…)
- Electrofishing (2012, 2014,…)
- Macroinvertebrates sampling (2012, 2014,…)
- Hydromorphological quality indexes (2012, 2014,…)

Comparison between before/after works

Improvement ?

Tool for assessing the success of river restoration works

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