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and
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Ecologically effective colmation by fine sediment input and its measurement



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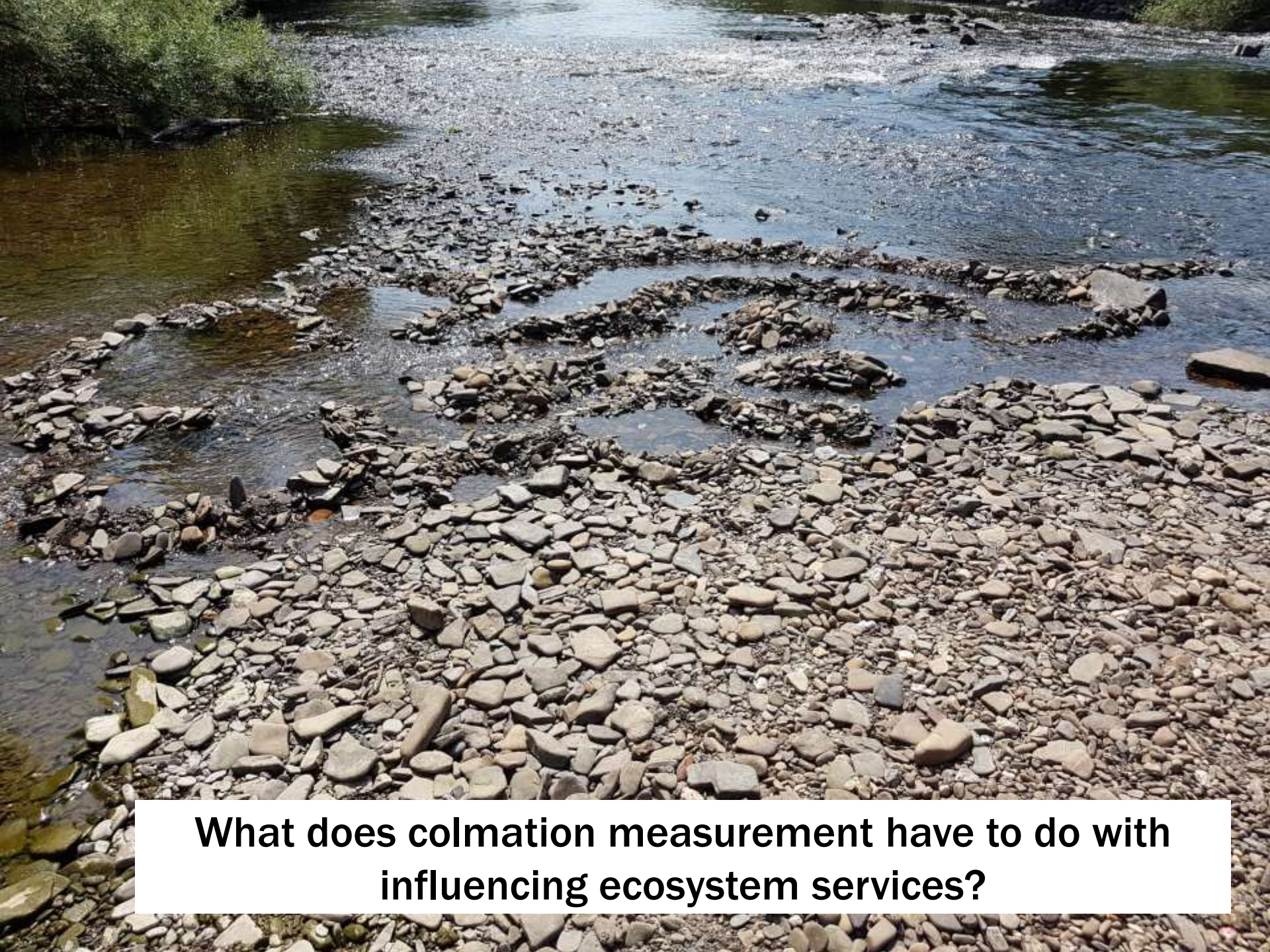


What does colmation measurement have to do with influencing ecosystem services?

Water exchange between stream bottom, flowing wave and groundwater

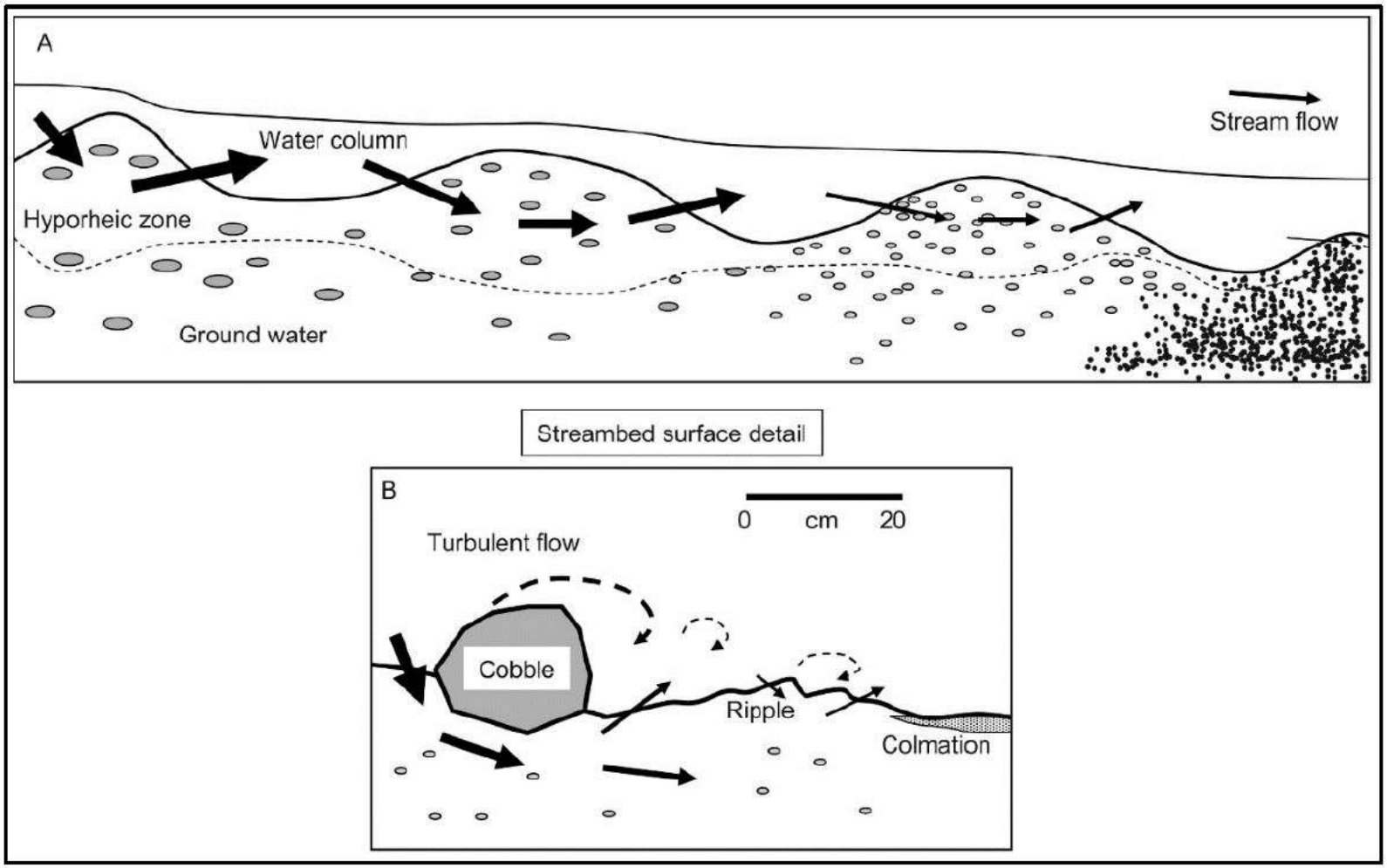


Illustration: Boulton et al. 2010

Limnologists call this habitat the “Hyporheic Interstitial”
Water economists call it: “Area of self purification”

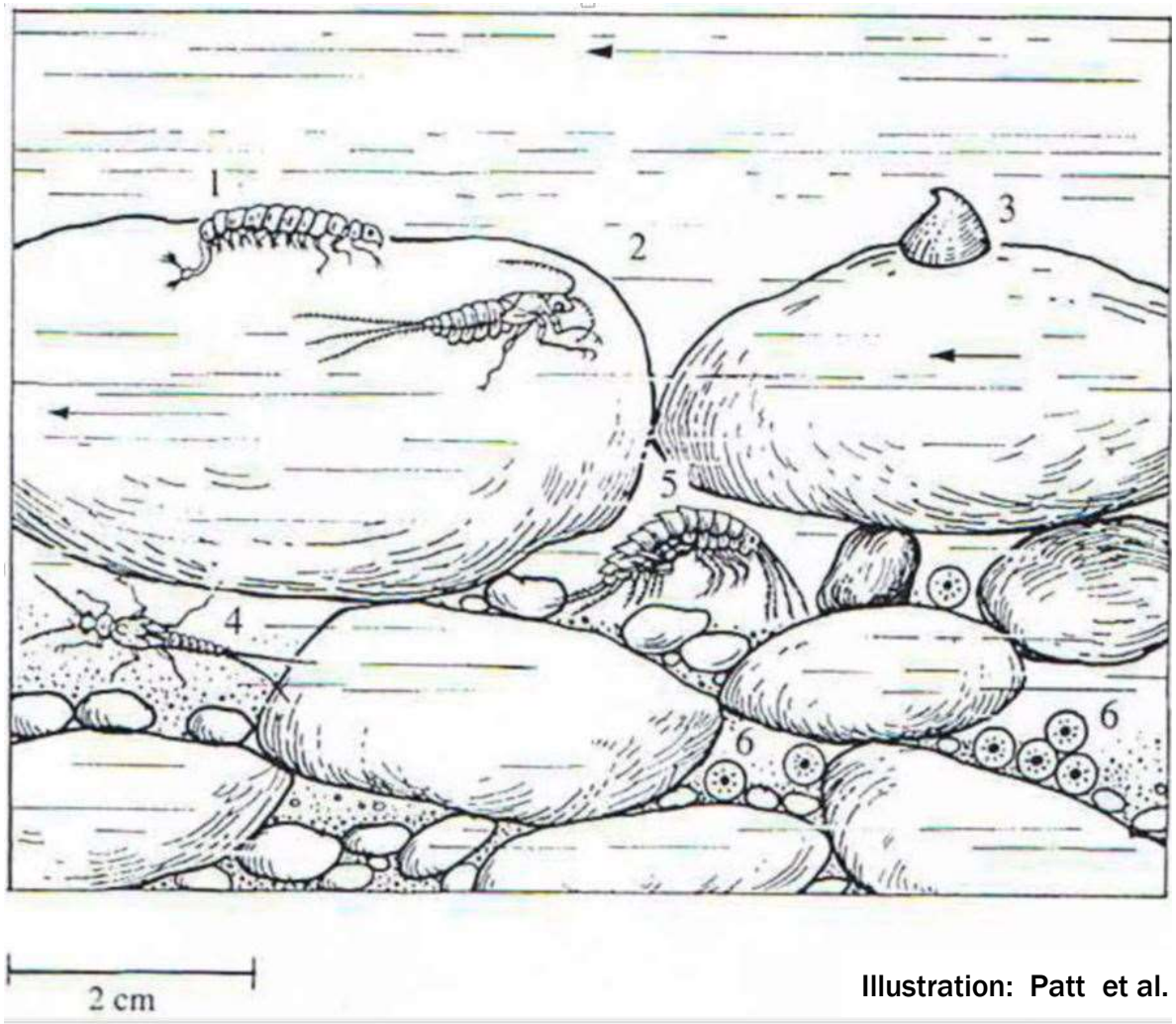
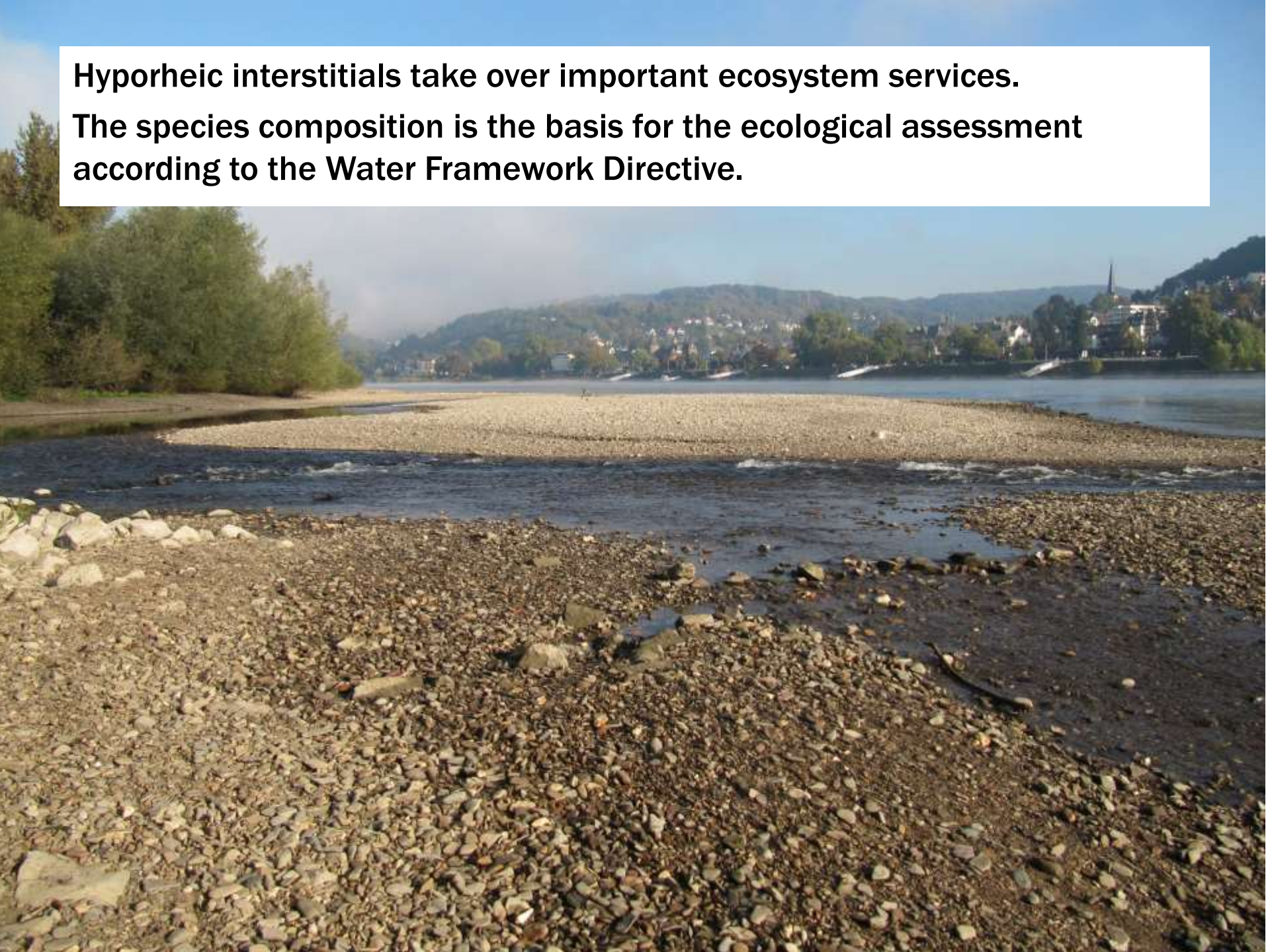


Illustration: Patt et al. 2004

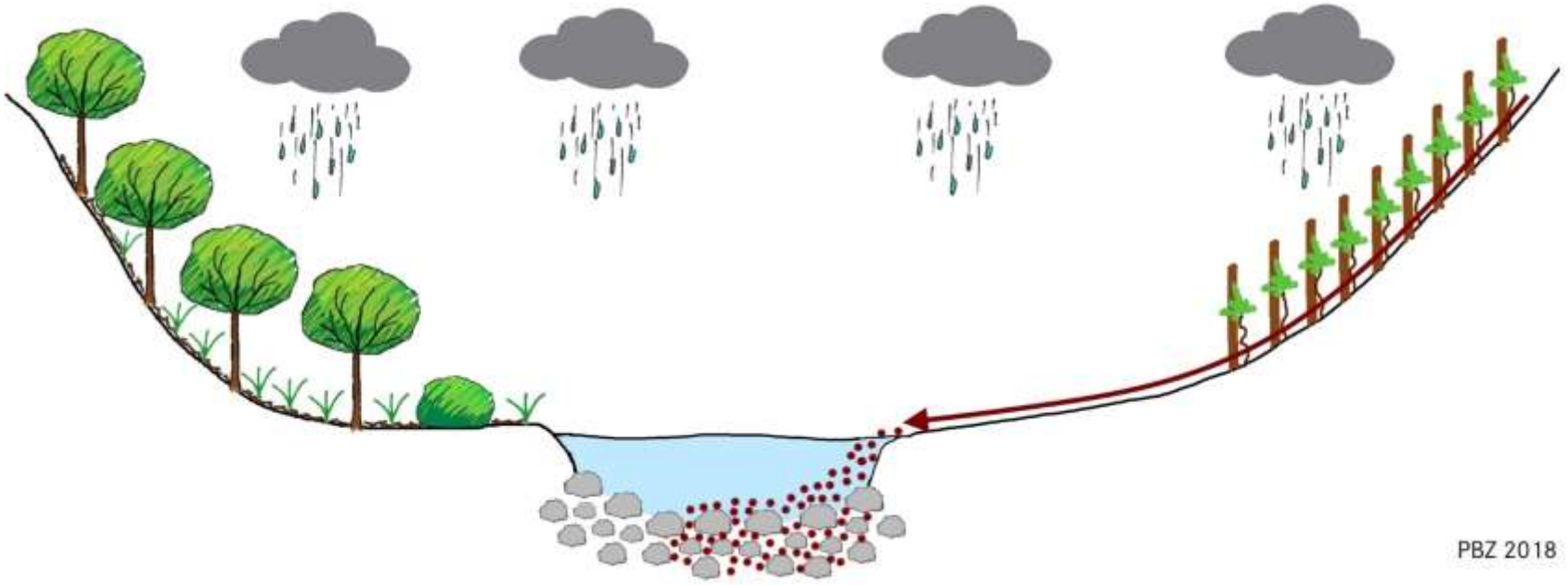


Hyporheic interstitials take over important ecosystem services.

The species composition is the basis for the ecological assessment according to the Water Framework Directive.

The phenomenon of colmation

Surface erosion and fine sediment input are a natural process. This leads to natural colmation. In case of heavy hydraulic loading, the fine sediments can be washed out: "self-cleaning filter".

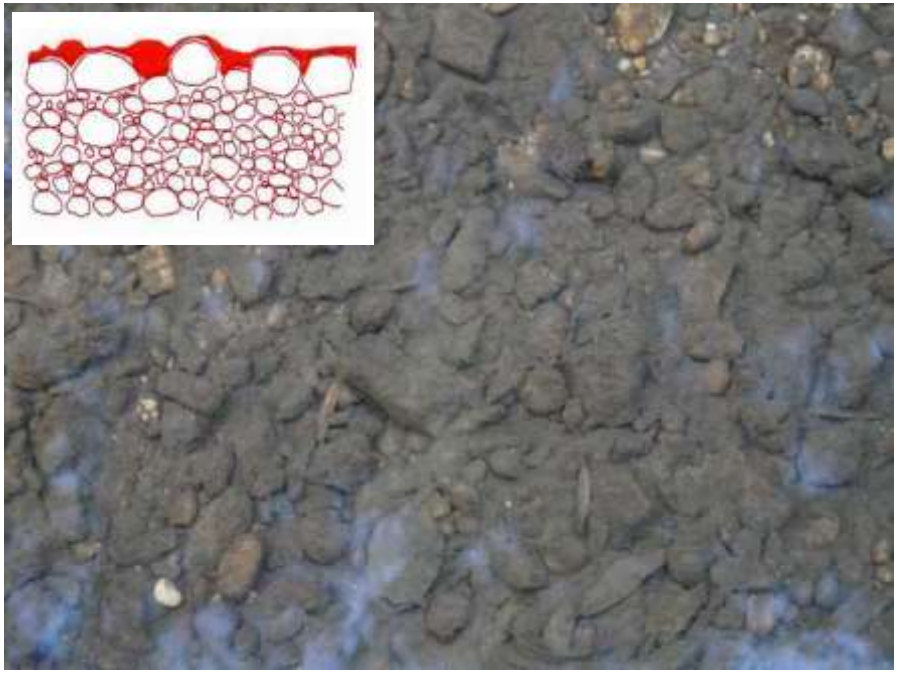


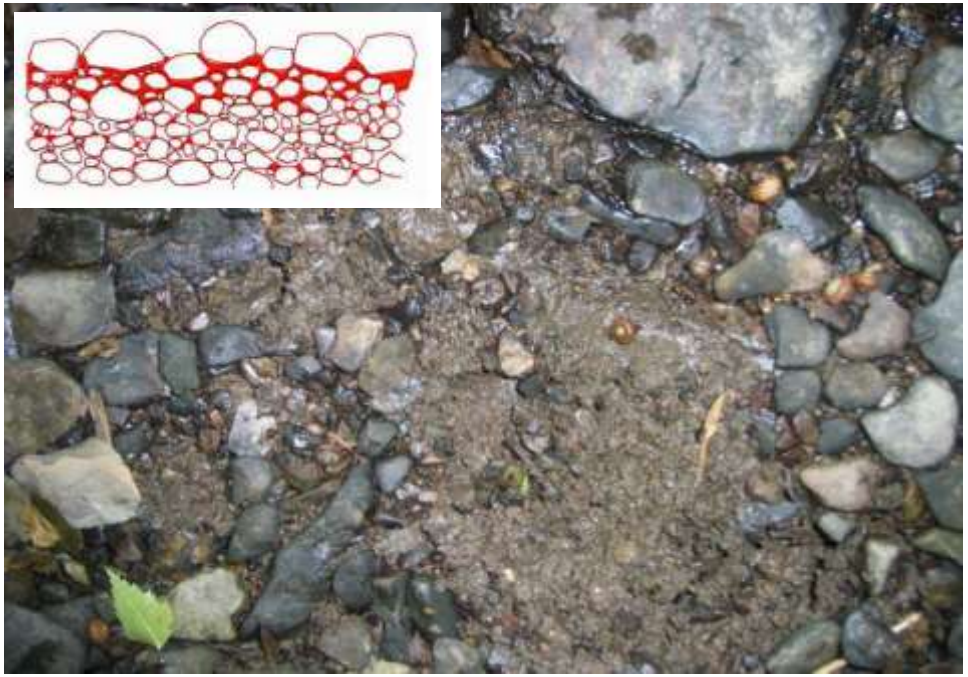

The biological monitoring of the WFD has identified that in many water bodies, species are missing although they could be expected according to the water typology.

It was noticeable that the brood of fish species such as salmon or trout, which lay their eggs in the gravel bed, died

The so called boot test gives an idea of the reason.

Distinction between external and internal colmation





Direct effects:

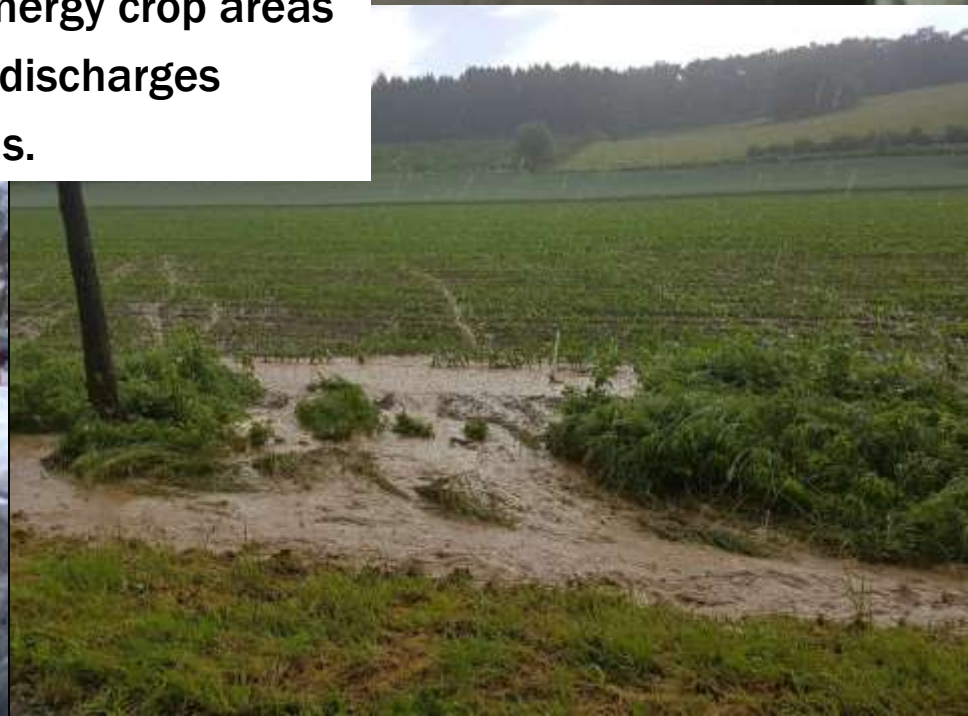
- **Loss of structural diversity**
- **Loss of pore spaces (= living space)**
- **Loss of permeability**

a = external colmation

b = internal colmation

Main anthropogenic sources:

- road drainage
- erosion of energy crop areas
- wastewater discharges
- air emissions.



What do we know about anthropogenic colmated watercourses?

Values of the inner colmation are only known from isolated studies in very few watercourses. There is also little reliable knowledge about the ecological effects and the influence of colmation on ecosystem services.

In addition, there are no natural quantitative reference values for the different types of watercourses.

Reasons for this knowledge gap are the complexity and the costs of existing quantitative methods. And simple methods do not provide quantitative results and are not precise and reliable. The results are interesting, but subjective and not very reproducible, as comparative studies have shown.

Methods for colmation detection

Colmation measurement by Schälchli

Tabelle 1: Kriterien für die Einstufung der inneren Kolmation nach (K1) aus (SCHÄLCHLI 2002)

Klasse	Bewertung	Indikatoren Substrat und Lückenraum unter der Deckschicht
1	Keine Kolmation	Substrat grobkörnig (Steine, Kies) Nur wenig Sand- und keine kohäsiven Ablagerungen Lückenraum dominant grobporig
2	Schwache Kolmation	Substrat locker und breit abgestuft (Steine, Kies, Sand) Keine kohäsiven Ablagerungen sichtbar (Silt, Ton) Lückenraum grob- bis feinporig
3	Mittlere Kolmation	Substrat leicht verfestigt Kontaktfläche etwa 1/4 mit kohäsiven Feinpartikeln verfüllt, übrige Kontaktfläche v.a. Sand, aber auch Kies und Steine) Lückenraum zu 3/4 feinporig, bei kohäsiven Ablagerungen keine Poren sichtbar
4	Starke Kolmation	Substrat deutlich verfestigt Kontaktfläche etwa zur Hälfte mit kohäsiven Feinpartikeln verfüllt, übrige Kontaktfläche vorwiegend Sand Örtlich noch feinporiger Lückenraum sichtbar
5	Vollständige Kolmation	Substrat stark verfestigt Kontaktfläche praktisch flächendeckend mit kohäsiven Feinpartikeln verfüllt Kein Lückenraum sichtbar

Freeze coring

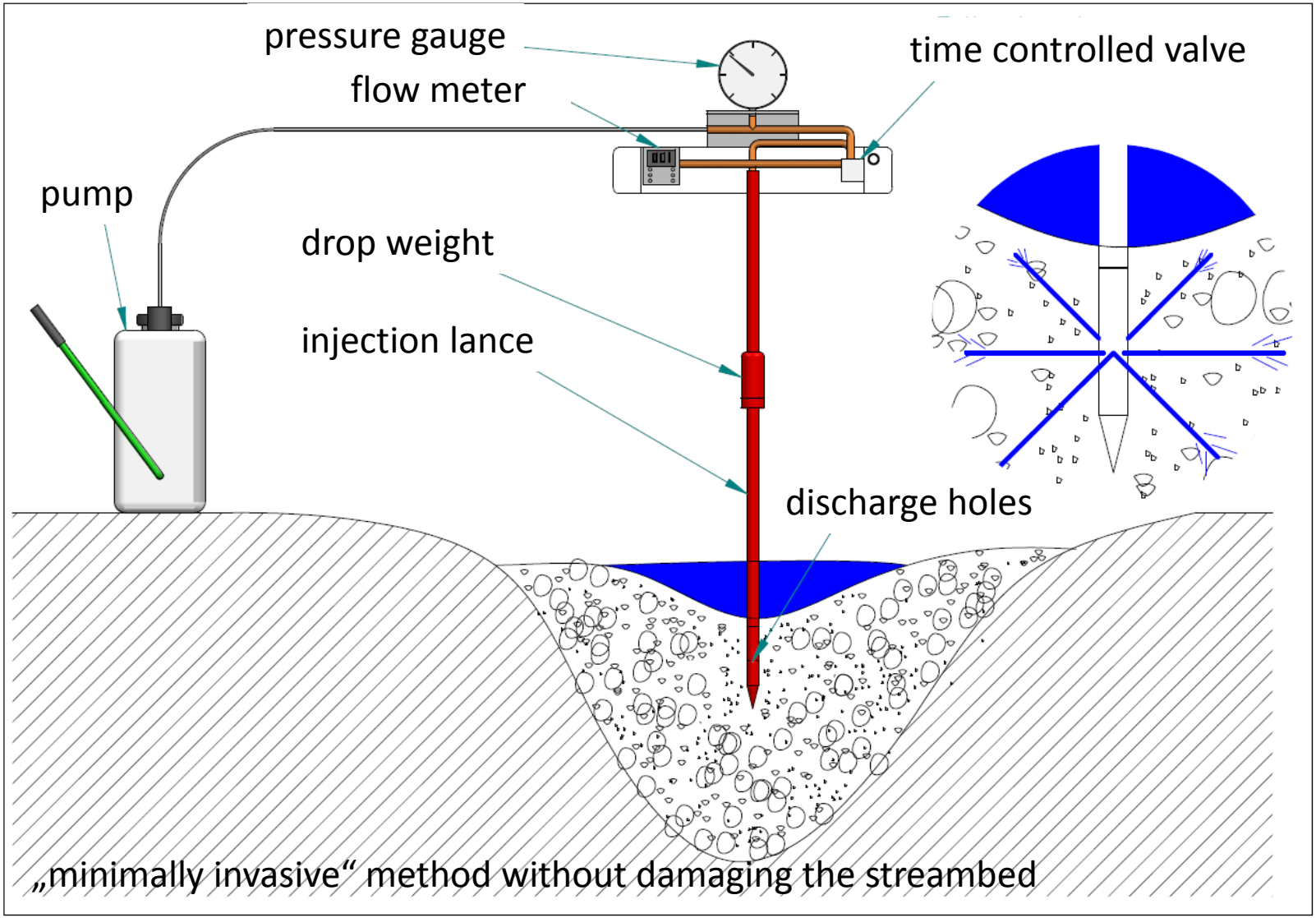
Sediment traps

Method evaluation

- Results are often not reproducible
- The methods are insensitive to minor differences
- Findings are based on estimates and are often inaccurate
- Practical limit- and orientation values for the colmation evaluation are (therefore) not known.

Standardized quantitative methods are needed, which are easy, fast and don‘t damage the stream sediments, but provide repeatable results.

A new device: the Kolmameter



Das **Kolmameter®**

nach Hahn & Zumbroich

„Untergrunddurchlässigkeitsmessgerät “

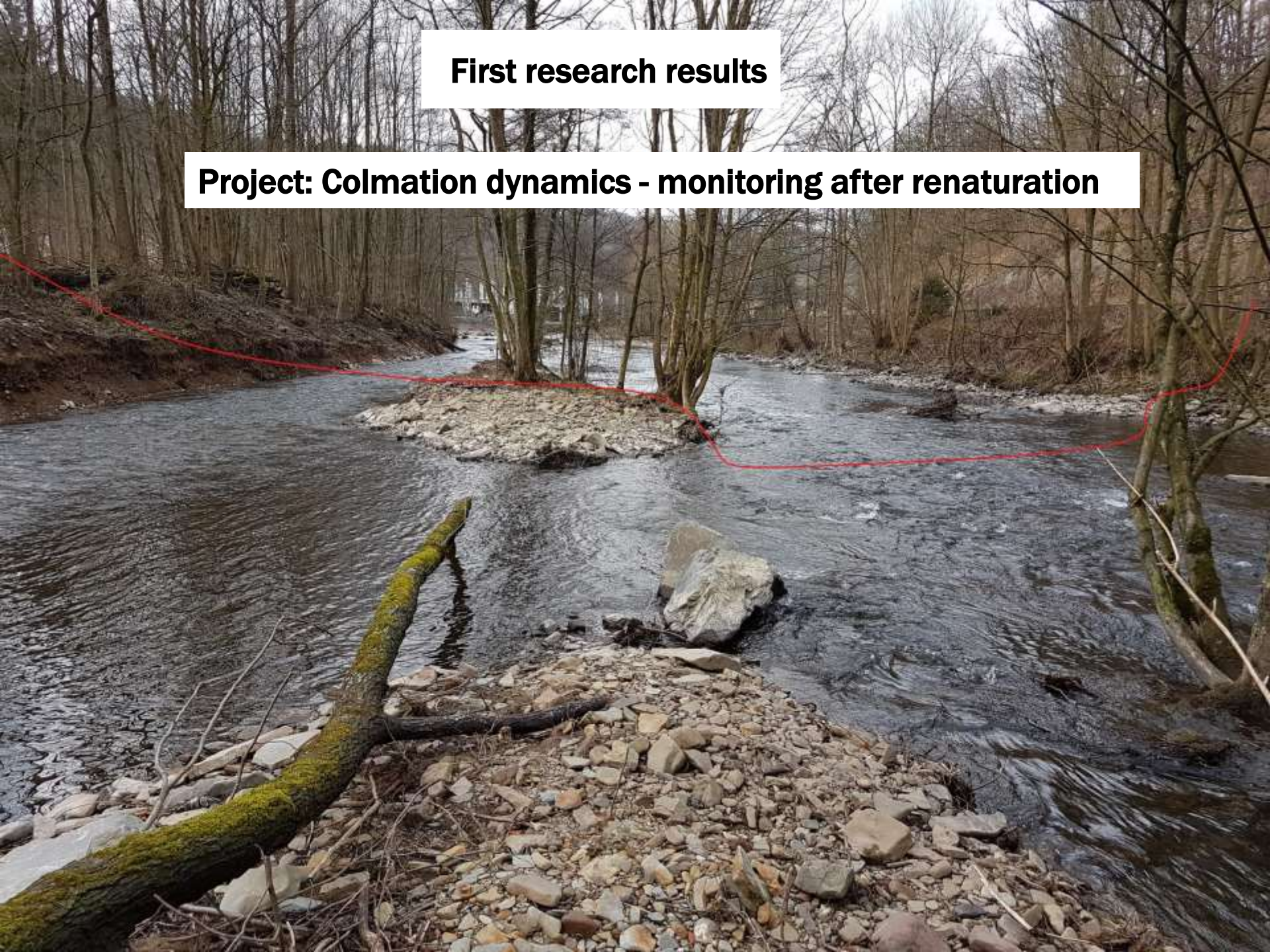
Europäisches Patentamt
European Patent Office
Office européen des brevets

Patent-Nr.: 3159671

Classification of outflow reduction, determined under laboratory conditions

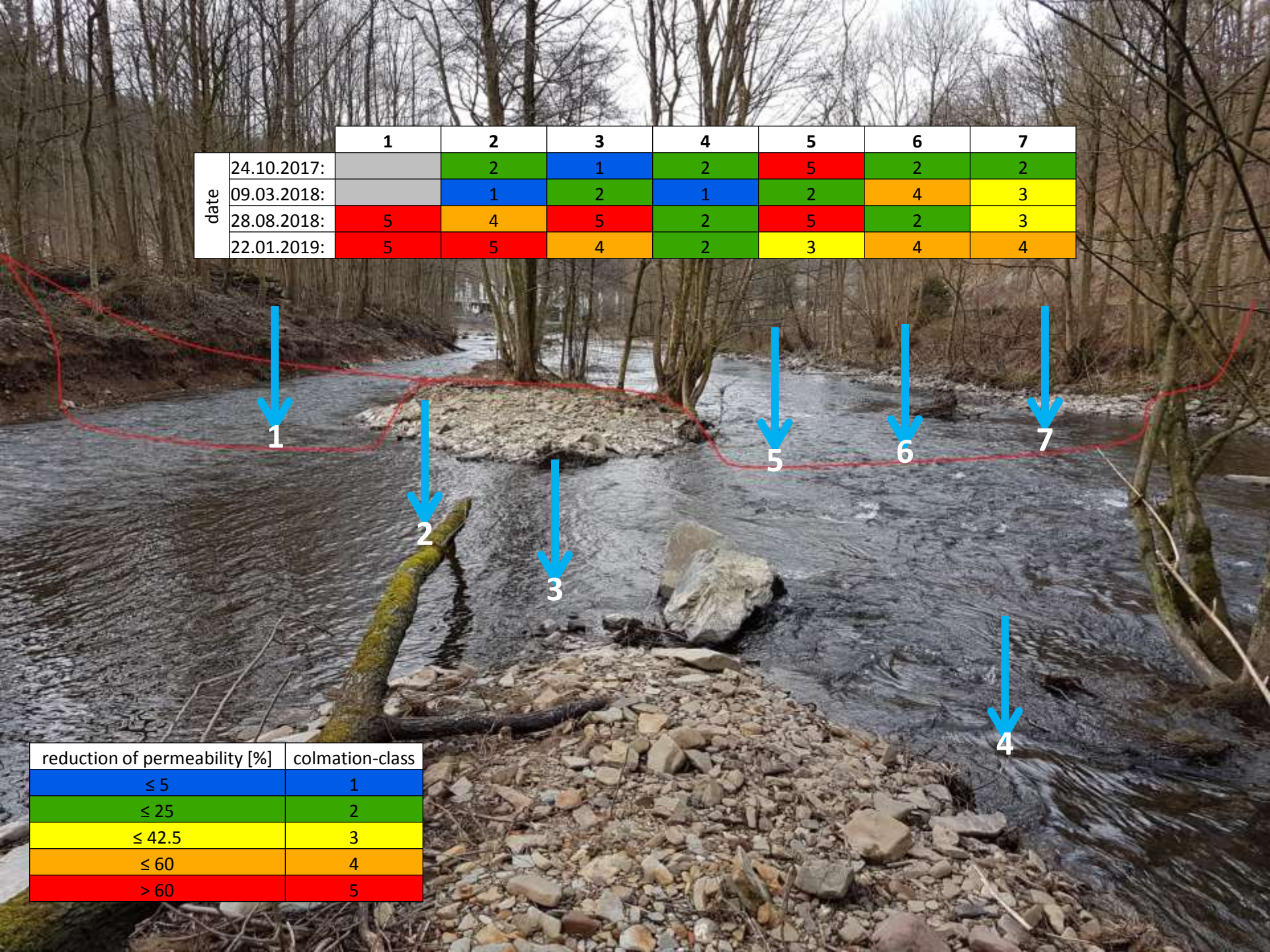
outflow reduction in sediment compared to air [%] 18 holes/0,1 bar	**colmation class**	
0 - 5	no internal colmation	1
5 - 25	weak internal colmation	2
25 - 42,5	middle internal colmation	3
42,5 - 60	strong internal colmation	4
> 60	very strong internal colmation	5

The stronger the outflow reduction the stronger colmation!



First research results

Project: Colmation dynamics - monitoring after renaturation

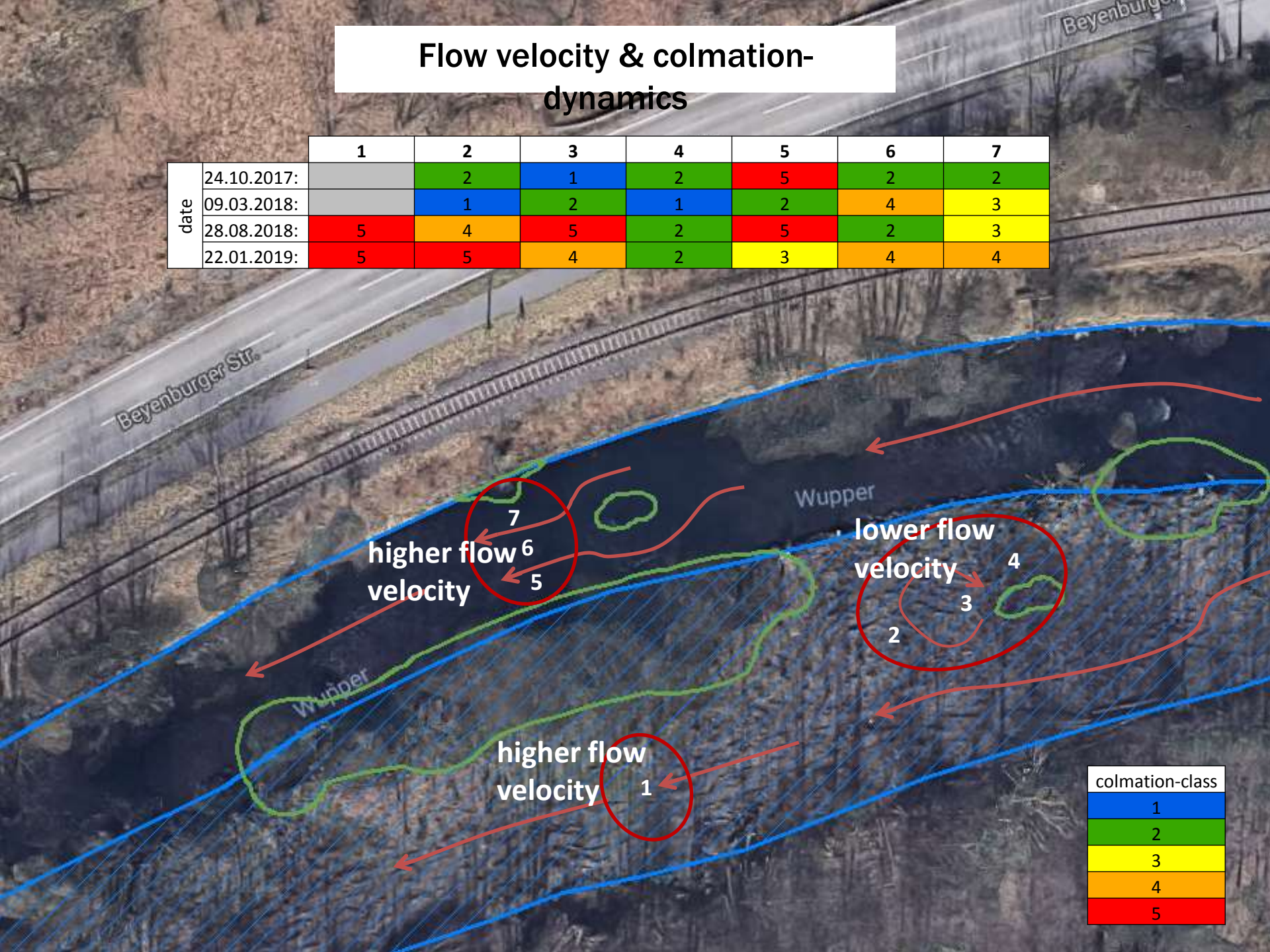


		1	2	3	4	5	6	7
date	24.10.2017:		2	1	2	5	2	2
	09.03.2018:		1	2	1	2	4	3
	28.08.2018:	5	4	5	2	5	2	3
	22.01.2019:	5	5	4	2	3	4	4

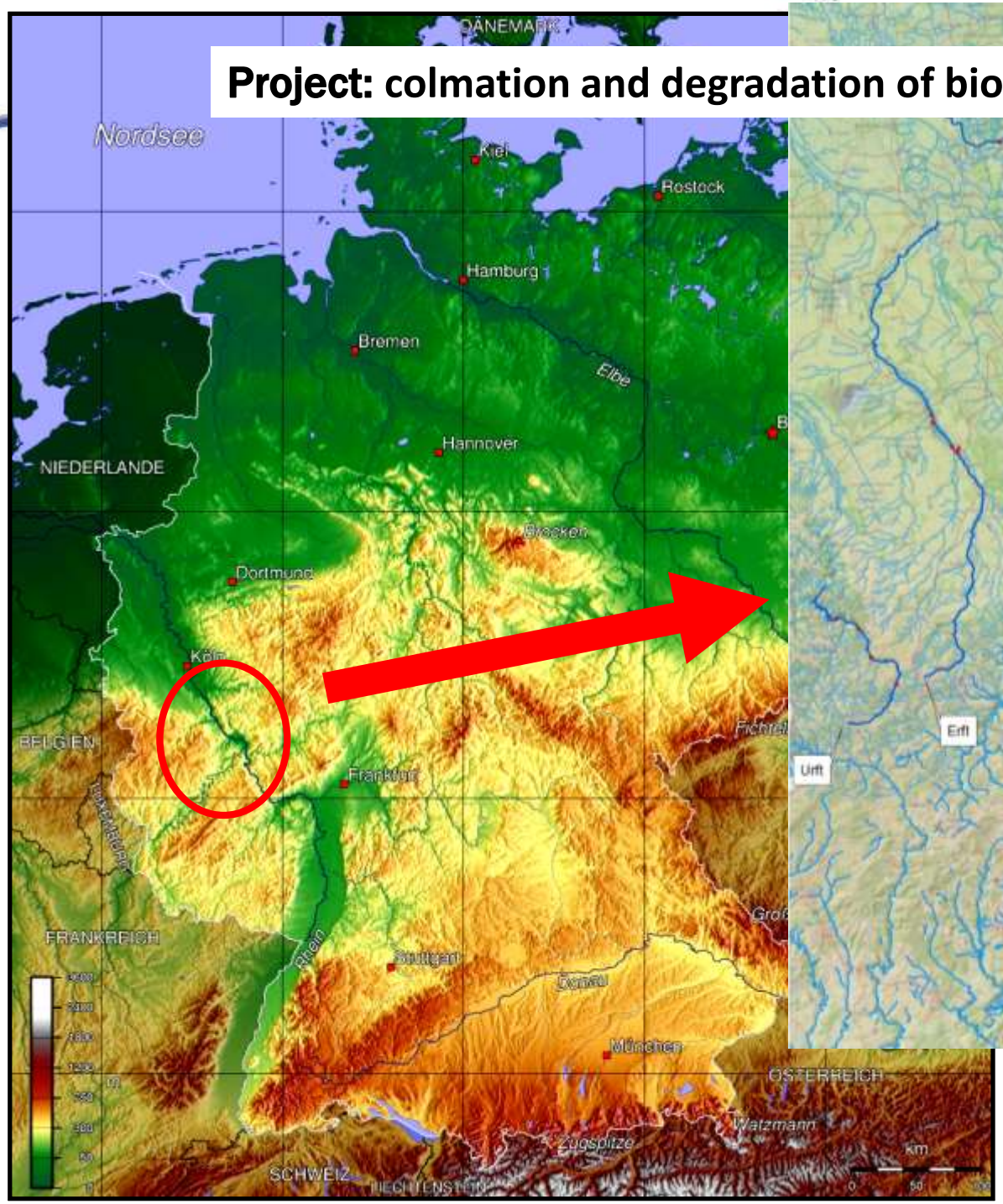
reduction of permeability [%]	colmation-class
≤ 5	1
≤ 25	2
≤ 42.5	3
≤ 60	4
> 60	5

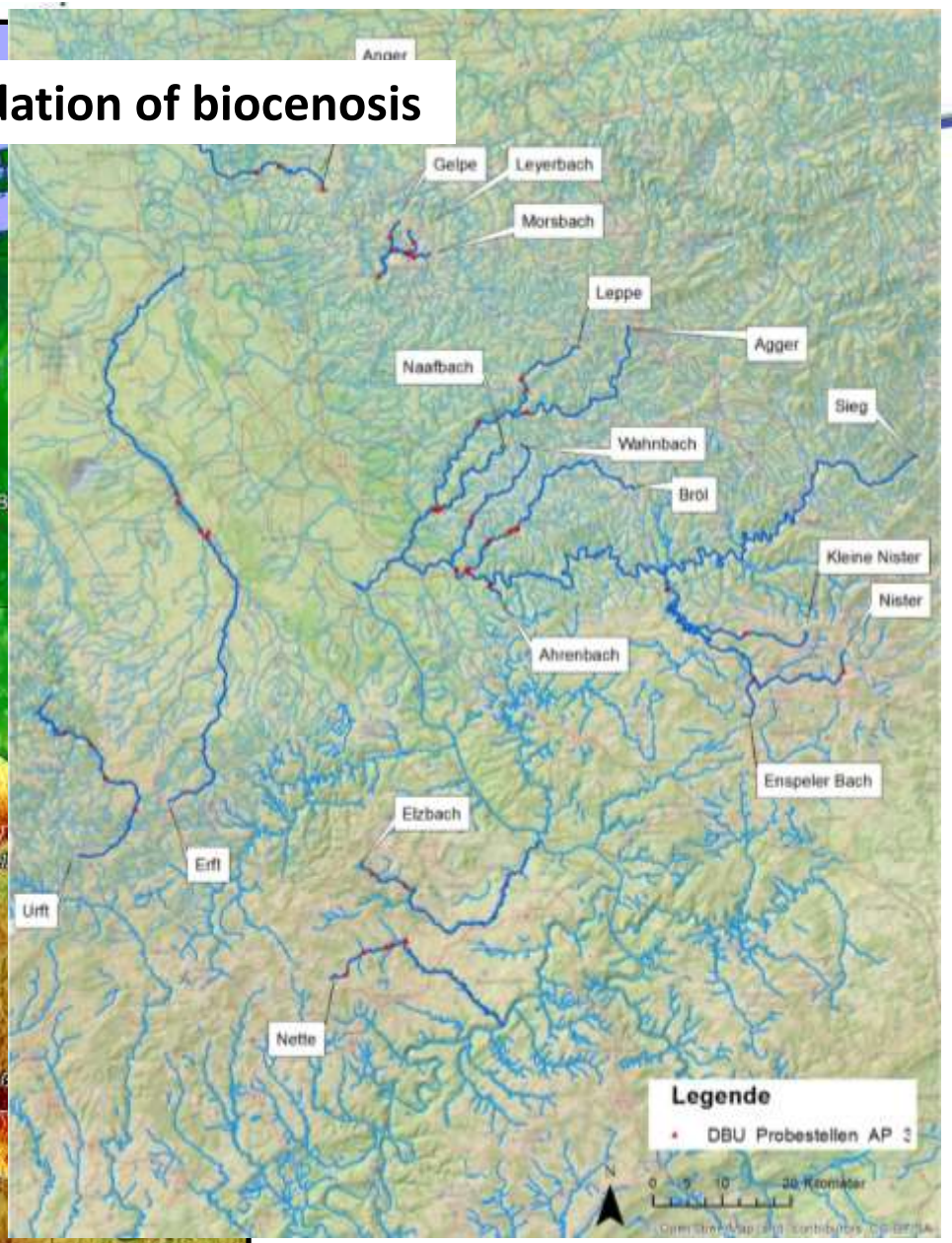
Flow velocity & colmation-dynamics

		1	2	3	4	5	6	7
date	24.10.2017:		2	1	2	5	2	2
	09.03.2018:		1	2	1	2	4	3
	28.08.2018:	5	4	5	2	5	2	3
	22.01.2019:	5	5	4	2	3	4	4

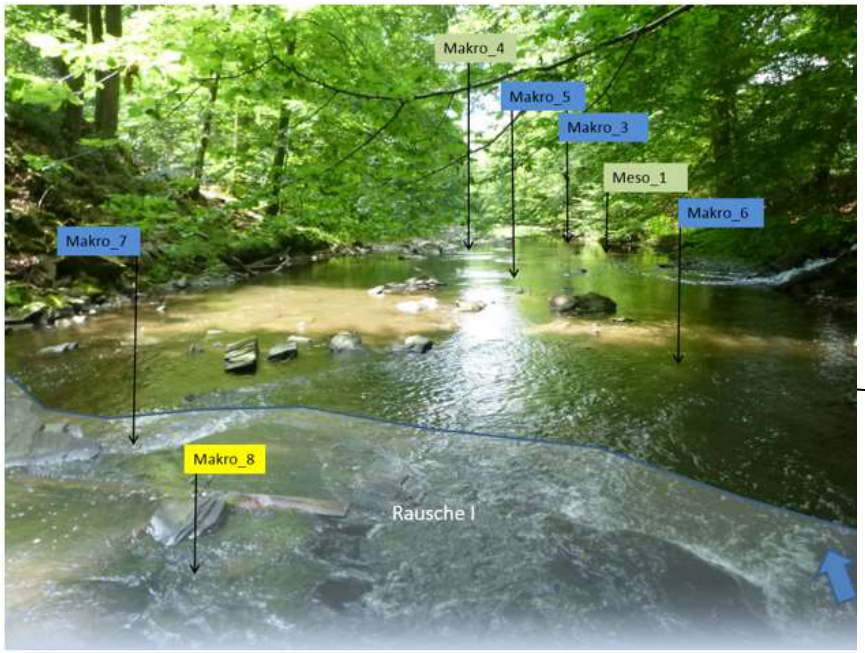


Project: colmation and degradation of biocenosis





First research results



Interpretation of the Kolmameter measurements

Site	Colmation class	PERLODES general degradation	PERLODES eceological status class	Morphological sructure of the streambed	General morphological sructure
Bröl_4	2	2	2	1	2

Source: Thurmann et al. 2017

Lfd. Nr.	Bundesland	Name	Probestellenbezeichnung	LAWA-Typ*	PERLODES			Kolmameter Klasse	Gewässerstrukturgüte (GSK)	
					Datum	ökologische Zustandsklasse*	Allgemeine Degradation*		Bewertung Sohle**	Bewertung gesamt**
1	NRW	**Agger**	Agger_1	9	2013	4	4	3	4	4
2			Agger_2	9	2013	3	3	3	5	6
3	NRW	Agger+_**Leppe**	Leppe_1	5	2005	2	2	2	4 (5)	4 (5)
4			Leppe_2	5	2013	2	2	2	4 (5)	5 (6)
5	NRW	Agger+_**Naafbach**	Naafbach_1	5	2013	3	3	4	5	5
6			Naafbach_2	5	2013	3	3	2	3	3
7			Naafbach_3	5	2013	2	2	2	3	3
8			Naafbach_4	5	2013	2	2	2	2	3
9	NRW	**Ahrenbach**	Ahrenbach_1	5	2014	2	2	3	3***	3***
10			Ahrenbach_2	5	2017	2	2	4	5***	5****
11	NRW	**Anger**	Anger_1	7	2013	3	3	3	2	2
12			Anger_2	7	2013	3	3	3	6	5
13			Anger_3	7	2013	5	5	4	5	5
14	NRW	**Bröl**	Bröl_1	9	2014	3	3	2	5	5
15			Bröl_2	9	2014	2	2	2	3	4
16			Bröl_3	9	2014	3	3	3	6	5
17			Bröl_4	9	2014	2	2	2	1	2
18			Bröl_5	9	2014	2	2	2	3	2
19			Bröl_6	9	2014	1	2	2	2	2
20		Bröl_**Waldbrölbach**	Bröl_7	5	2014	2	2	2	3	5
21	RLP	**Elzbach**	Elzbach_1	5	2008	k.A.	3	3	5	6
22			Elzbach_2	5	2008	k.A.	3	3	3	3
23			Elzbach_3	5	2008	k.A.	3	3	3	3
24			Elzbach_4	5	2008	k.A.	3	4	6 (3)	6 (4)
25			Elzbach_5	5	2008	k.A.	3	3	3	2
26	NRW	**Erft**	Erft_1	17	2015	2	2	2	5	5
27			Erft_2	17	2017	3	2	3	6	6
28	NRW	Erft_**Liblarer Mühlengraben**	Erft_3	17	2012	5	5	4	5	6
29		Erft	Erft_4	17	2009	2	1	3	5	6
30		Erft_**Kleine Erft**	Erft_5	17	2012	3	3	4	5	6
31	NRW	**Morsbach**	Morsbach_1	5	2013	3	3	2	3	4
32			Morsbach_2	5	2013	2	2	3	3	3
33			Morsbach_3	5	2013	2	2	2	2 (4)	3 (4)
34	NRW	Morsbach+_**Gelpe**	Gelpe_1	5	2013	2	2	3	1	1
35		Morsbach+_**Leyerbach**	Leyerbach_1	5	2006	4	4	2	6 (7)	7
36		Morsbach+_**Gelpe**	Leyerbach_2	5	2013	2	2	3	4 (3)	4 (3)
37		Morsbach+_**Leyerbach**	Leyerbach_3	5	2006	5	5	4	7	6
38	RLP	**Nette**	Nette_1	5	2008	k.A.	4	2	2 (3)	3
39			Nette_2	5	2008	k.A.	2	2	2 (3)	3
40	RLP	**Nister**	Nister_1	9	2008	3	3	2	2	3
41		Nister+_**Enspeler Bach**	Nister_2	5	2007	3	3	2	2	2
42		Nister+_**Kleine Nister**	Nister_3	5	2007	k.A.	3	2	2	2
43		**Nister**	Nister_4	5	2008	k.A.	4	4	4 (2)	4 (2)
44	NRW	**Sieg**	Sieg_1	9.2	2014	2	2	2	1	1
45			Sieg_2	9.2	2014	2	2	2	3	3
46	NRW	**Urft**	Urft_1	9	2012	2	2	2	2	2
47			Urft_2	9	2012	2	2	2	1	3
48			Urft_3	7	2012	2	2	2	1	2
49			Urft_4	5	2012	3	3	3	4 (2)	4 (3)
50	NRW	**Wahnbach**	Wahnbach_1	5	2014	3	3	3	2	2

Outlook

- As areas of self-purification, water sediments provide important ecosystem services.
- Anthropogenic pollution with fine sediments from various sources is increasing worldwide. This leads to colmation and thus to a reduction in biological activity.
- In order to be able to quantify the problem seriously and to develop strategies to solve the problem, the importance of colmation must be more public.
- In addition to strategies to prevent fine sediment deposition, gaps in knowledge about colmation dynamics, resilience, effects on biology and much more must be closed.
- With the new measuring device, the Kolmameter, probably important new findings can be found.

Thank you for your attention

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