



Restoration Strategies in European Rivers Overview of Approaches and Experiences

Marie-Pierre Gosselin

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CEDREN-Trondheim

Outlook of presentation

- Introduction: tools and approaches available for river restoration in Europe
- Example: restoration strategy for the freshwater pearl mussel in the North Tyne
- Conclusion and lessons learned

Introduction 1: tools for river restoration in Europe

- ***ECWater Framework Directive (200/60/EC; WFD)***
 - > River Basin Management Plans
 - > Good Ecological Status (Potential)
- ***Habitats and Species Directive (92/43/EEC)***
 - > 200 „habitat types“ of European Importance (including aquatic habitats).
 - > Natura 2000 network
 - > Strict protection of listed species

Introduction 2: Approaches for river restoration in Europe

- ***Focus on species***
 - > Umbrella species, surrogate indicators
 - > Species assemblages as indicators of water quality (e.g. ASPT, EPT Index)
- **Focus on habitat**
- **Focus on whole ecosystem**
 - > Ecosystem-Based Management (EBM)

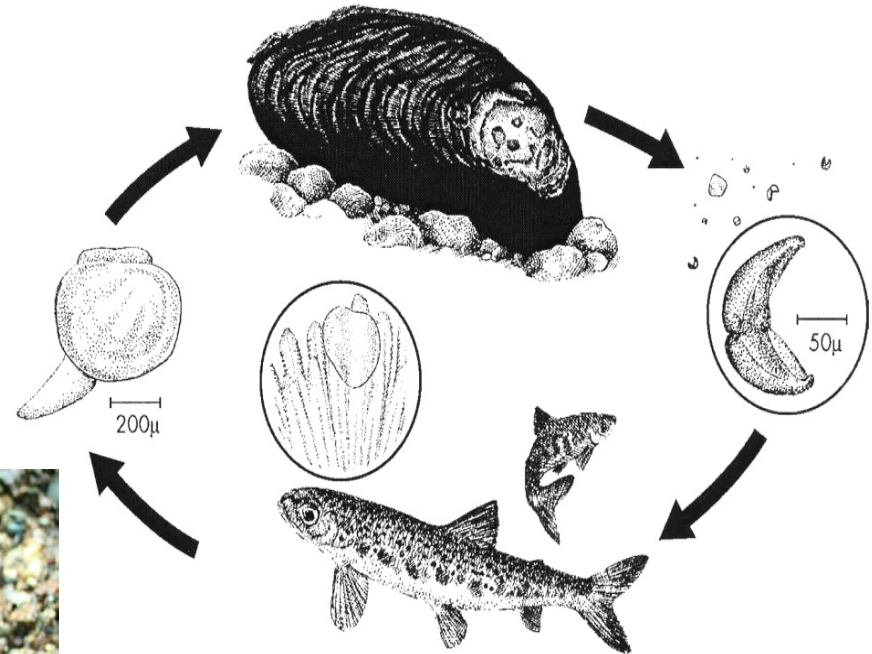
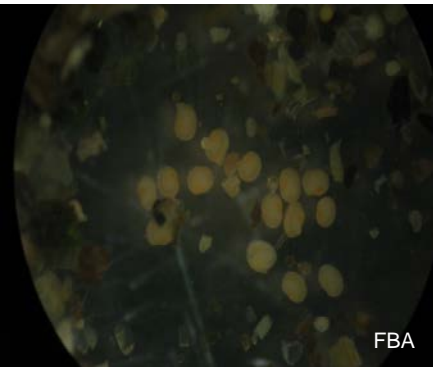
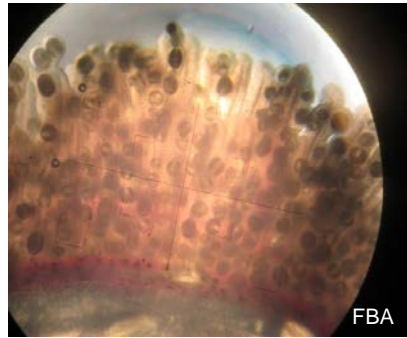
“an integrated approach to management that considers the entire ecosystem including humans. The goal of EBM is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. EBM differs from current approaches that usually focus on a single species, sector or activity or concern; it considers the cumulative impacts of different sectors” (Long et al., 2015)

A photograph of a river flowing through a wooded area. The water is calm, reflecting the overcast sky. Several large, moss-covered rocks are scattered throughout the river. Bare tree branches frame the top and sides of the image, creating a sense of enclosure. The overall tone is muted and naturalistic.

Example

Designing a restoration strategy for the freshwater pearl mussel in the North Tyne catchment, north east England

STEP 1: Freshwater pearl mussel ecology and life cycle



Habitat requirements:

- low level of nutrients
- clean river substrate
- healthy host fish population
- natural flow regime

Sarah Wroot

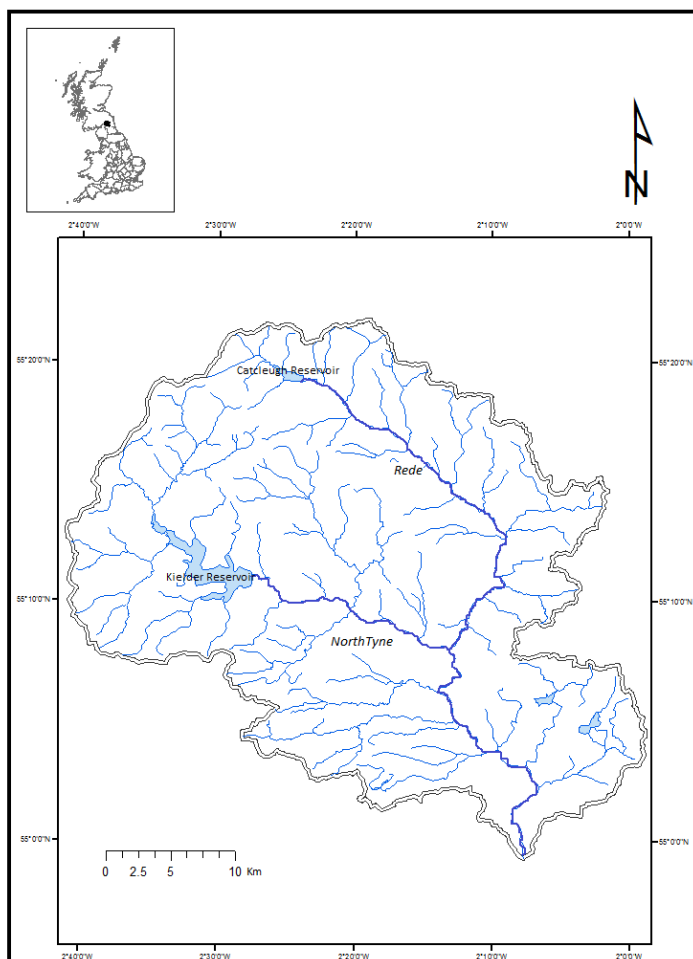
- Keystone and umbrella species
- Indicator of ecosystem health
- Can live up to 120 years

Literature review on water quality requirements

Water quality parameter	Requirement	References
Biochemical Oxygen Demand (B.O.D)	<1.4 mg.L ⁻¹	Bauer, 1988
Dissolved oxygen water	Continuously >9 mg.L ⁻¹	Skinner et al., 2003
pH	6.5 to 7.3	Osterling et al., 2010
Turbidity	<10 NTU (peaks); <0.3 NTU (all times)	Skinner et al., 2003
	<1 NTU	Degerman et al., 2009
Suspended sediments	<10 mg.L ⁻¹	Skinner et al., 2003
Soluble Reactive Phosphorus	< 25 ug.L ⁻¹	Moorkens, 2006
Nitrate	<0.125 mg.L ⁻¹	Moorkens, 2006
	<1 mg.L ⁻¹	Skinner et al., 2003
Conductivity	<100uS.cm ⁻¹	Skinner et al., 2003

Source: Gosselin, M-P. (2015) "Conservation of the freshwater pearl mussel (*Margaritifera margaritifera*) in the river Rede, UK: Identification of instream indicators for catchment-scale issues". *Limnologica* **50**:58-66.

Step 2: Identification of catchment characteristics, land use and pressures



- Catchment area: 1118 Km²
- North Tyne: 66 Km long; Rede: 58 Km long
- Two reservoirs: Kielder (HEP) and Catcleugh
- Fish stocking: 72 000 to 320 000 Atlantic salmon parr every year

Land use	North Tyne	Rede
Grassland	57	82
Forestry/ woodland	37	17
Arable farmland	4	0
Urban	0	0
Water	2	2
Semi-natural	0	0
Total	100%	100%



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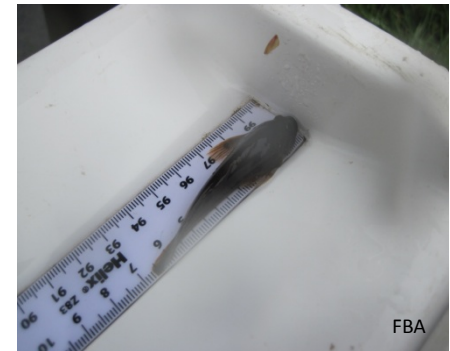


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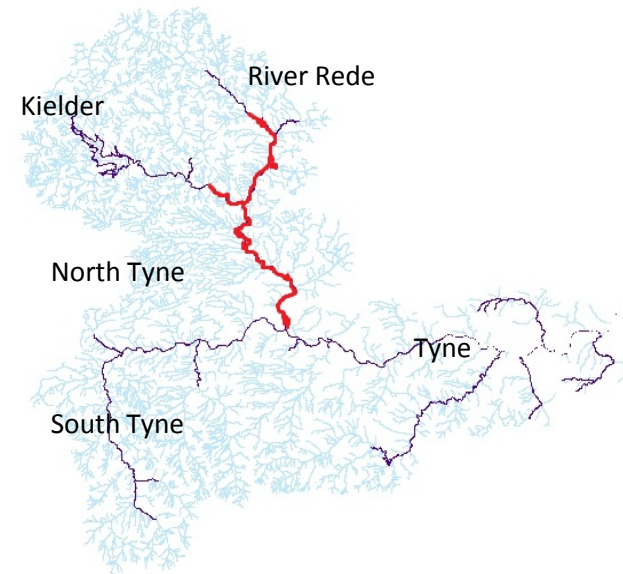
Fish diversity in the catchment

- Brown trout (*Salmo trutta*)
- Eel (*Anguilla anguilla*)
- Brook lamprey (*Lampetra planeri*)
- Bullhead (*Cottus gobio*)
- Atlantic salmon (*Salmo salar*)
- Stone loach (*Barbatula barbatula*)
- Minnow (*Phoxinus phoxinus*)



The freshwater pearl mussel in the North Tyne catchment

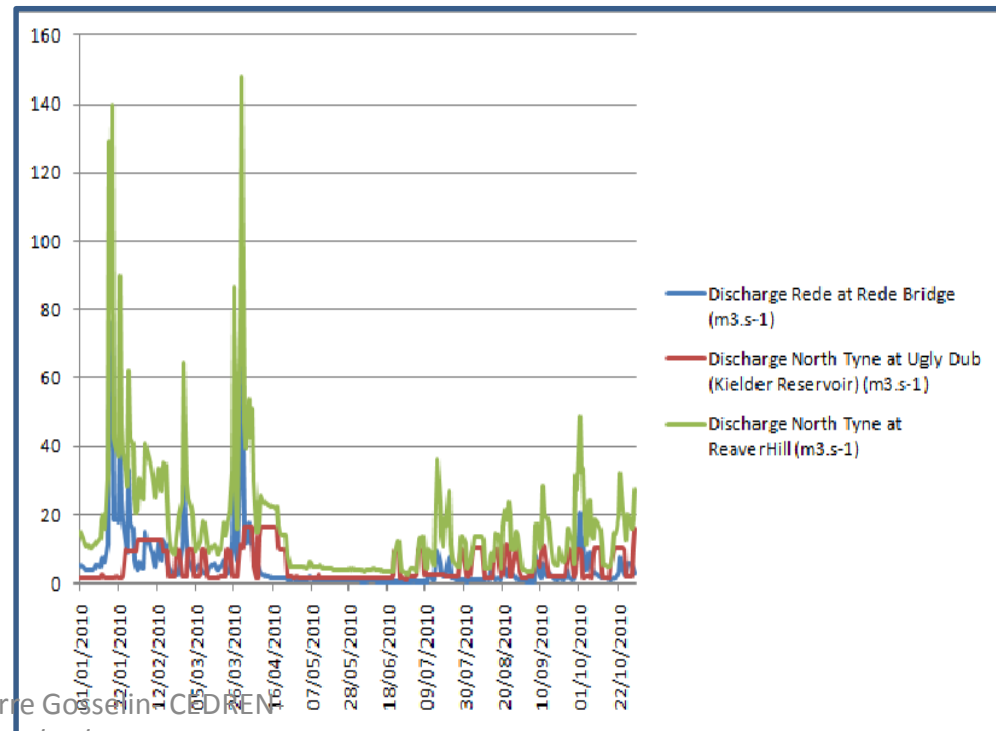
- Distribution limited to the Rede and the North Tyne downstream of its confluence with the Rede.
- Population: around 25,000 counted individuals (2006 survey)
- Most mussels are over 60-80 years old
- No apparent recruitment
- Host fish historically believed to be Atlantic salmon (*Salmo salar*). No success from the release of artificially infected juvenile fish



Kielder dam



- 200 M L water
- Built between 1976-1981
- Compensation flow: $1.32\text{m}^3.\text{s}^{-1}$
- HEP releases at present 9, 12 or $15\text{ m}^3.\text{s}^{-1}$ for 3, 5 or 7 days depending on reservoir level.
- Ramping time 4 hours



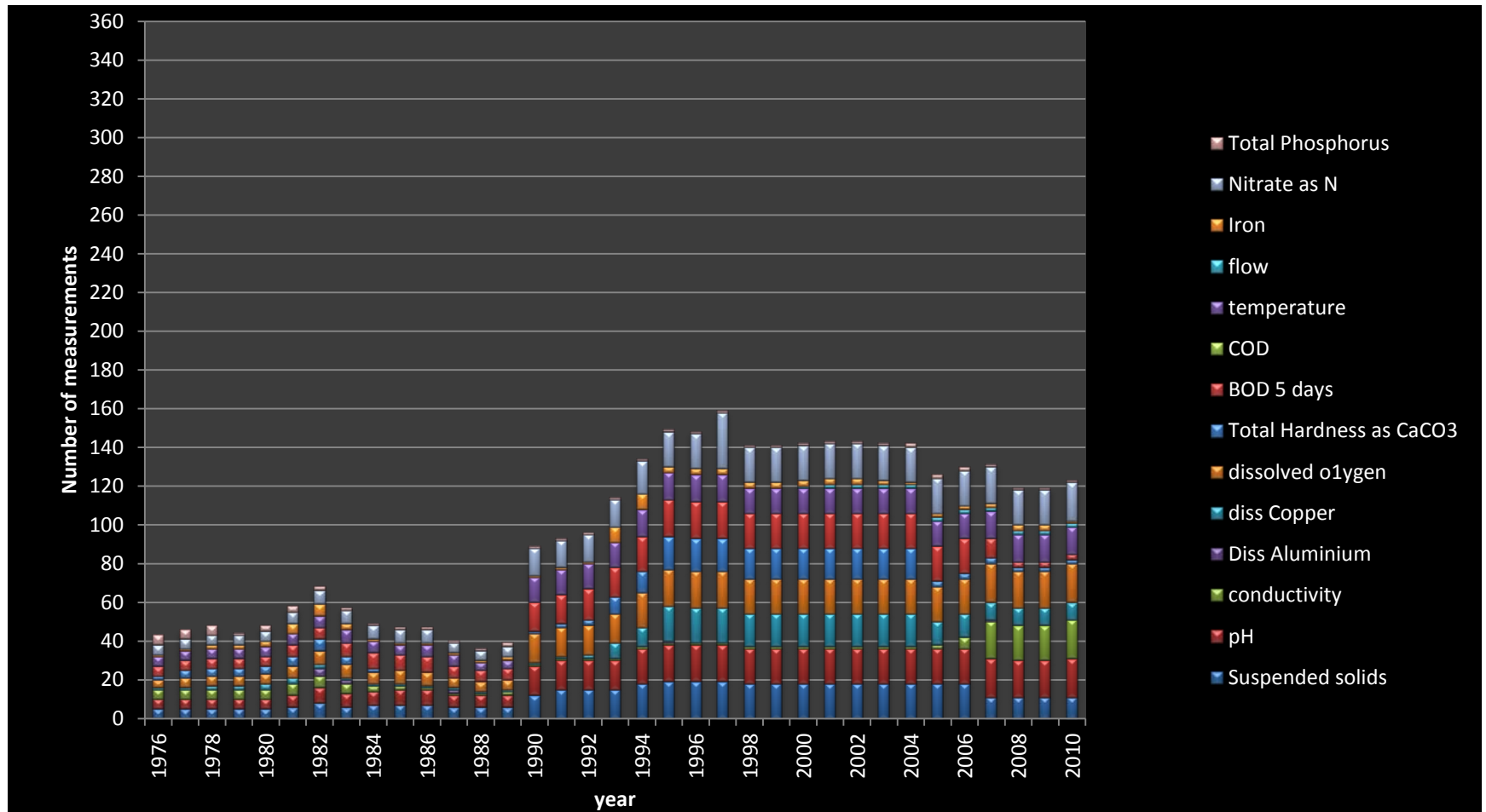
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Fish stocking

Year	Total North Tyne	Total Rede	Total salmon stocked
2000	224,200	89,000	313,200
2001	167,000	93,000	260,000
2002	42,500	30,000	72,500
2003	102,500	28,500	133,000
2004	238,000	115,000	353,000
2005	165,000	95,000	260,000
2006	139,331	72,349	211,680
2007	139,880	114,710	254,590
2008	233,880	141,090	374,970
2009	203,347	127,175	330,522
2010	146,364	166,791	313,155

- Little or no tagging
- legal mitigation (160,000)

STEP 3: Historical and WFD related data analysis



Results from data analysis

- Usual measures of biodiversity (e.g. N species): ok
- WFD macroinvertebrate –based score (EQR): good to high
- Nutrients: low (even limiting for phosphorus and nitrate)
- WFD ecological status: moderate to good



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HOWEVER

- Monitoring strategy not relevant
- Low number of samples

Hypothesis:

- Enrichment and increase in fine sediments
- Fine sediments from erosion (sheep and cattle poaching)
- Enrichment as a result of agriculture, human activities.



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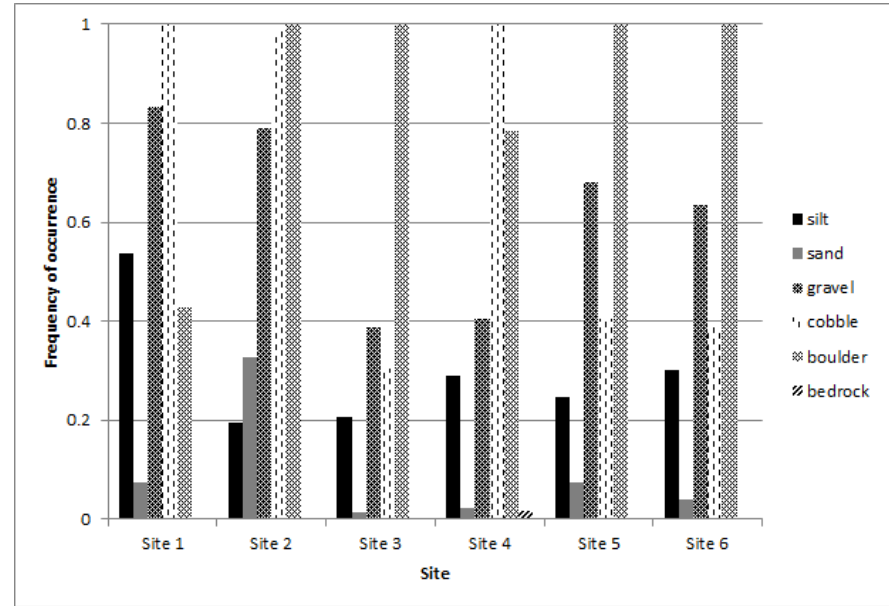
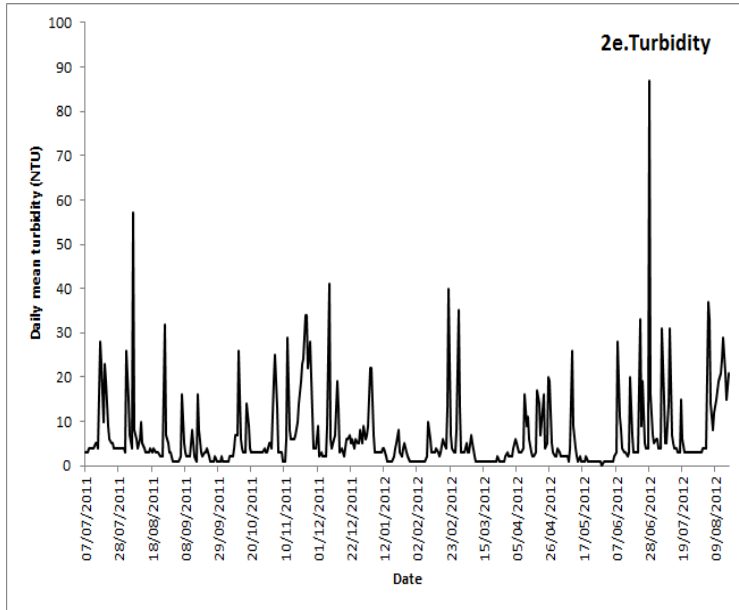


Tyne Rivers Trust

Step 4: Monitoring and field survey programme



STEP 4: Results



Site	N measurements	Water redox (mV)	Average redox in sediment (mV)(standard deviation)	Average redox loss (%) (standard deviation)
1	45	420	284 (33.7)	32.4 (8.0)
2	45	440	281 (21.4)	36.2 (4.9)
3	45	420	296 (24.1)	29.6 (5.7)
4	45	420	290 (35.6)	30.9 (8.6)
5	45	420	293 (23.7)	30.2 (5.7)
6	45	430	308 (20.9)	28.3 (4.9)

Step 5: Restoration strategy

Habitat and catchment-wide actions

- Implement a more comprehensive water quality monitoring programme
- Limit sediment input in the river
- Prevent nutrient input in the water
- Clean gravels: desilting
- Tree planting
- Fencing of banks to prevent access from cattle

Fish?

- Monitoring of salmonid populations, including released fish
- Trout is the host fish...

Dam?

Examples of habitat restoration



Lessons learned and conclusions

- The fewer the impacts the easier the restoration plan, in theory.
- WFD helps but not enough « on the ground » resources: monitoring ok but no « aim higher » attitude.
- The more sensitive your indicator or target, the more likely your management/restoration scheme will be demanding and expensive.
- Trade off between conflicting activities and species conservation. E.g. stocking for Atlantic salmon for anglers.
- Need to engage with stakeholders.
- Expectations have to be realistic and agreed upon between all partners.
- Beware of hidden political agendas.
- It does not always work out!

TAKK !

gosselin@igb-berlin.de

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Gosselin, M.-P., Martinez-Capel, F., and Muñoz-Mas, R. (2014) "Hydraulic habitat characterization and potential relationship with freshwater pearl mussel (*Margaritifera margaritifera*) occurrence in the river Rede, north-east England" in *Proceedings of the 10th International Symposium on Ecohydraulics*, 23rd - 27th June, Trondheim, Norway.