Modeling Contaminated Sediment in the Elbe River Basin: Integrating Field Data & Observations

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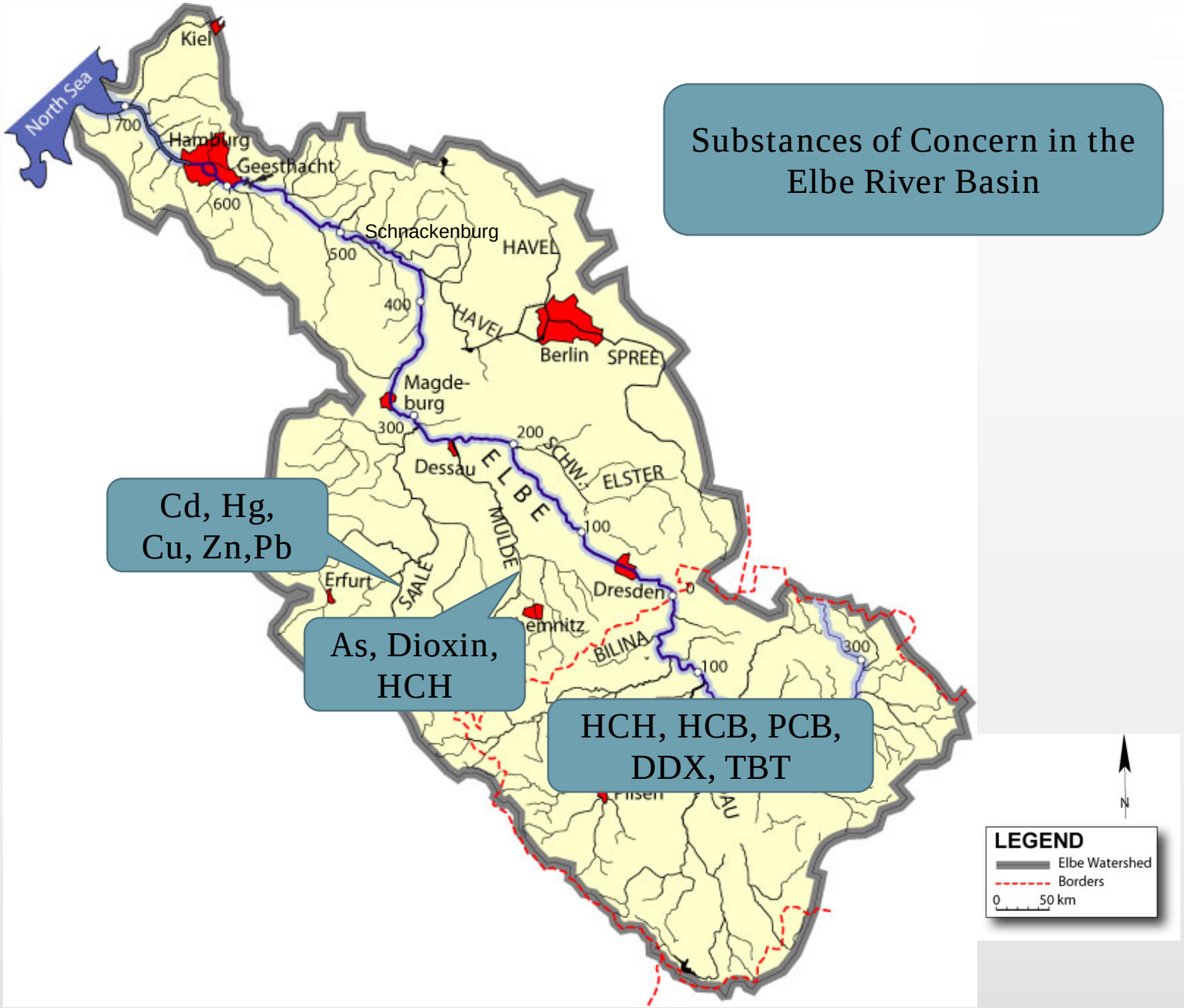
CONTENTS

WFD and the Elbe River Basin

- **Water Framework Directive**
  - EU Water bodies: Good chemical & ecological status by 2015
  - Some sections of the Elbe will likely fail WFD goals
- **Elbe Basin Sediments**
  - Areas of low sediment quality due to historical contamination.
  - Effect management measures (fishing, dredging)
- **Elbe Sediment Modeling:** Hydrodynamics, suspended sediment, and particle-bound contaminants
  - Describe erosion and deposition along and between groyne fields
  - Estimate transport of particle-bound contaminants – particularly from tributaries

Heise S, Krüger F, Baborowski M, Stachel B, Krätz O, Kortenhaus A. 2008. Bewertung der Risiken durch Feststoffgebundene Schadstoffe im Elbeeinzugsgebiet. Im Auftrag der FGG Elbe und HPA, erstellt vom BIS an der TU Hamburg-Harburg. Hamburg, 349 p.
Directive 2000/60/EC. *Directive 2000/60/EC.*
FGG Elbe. 2009. Hintergrundpapier zur Ableitung der überregionalen Bewirtschaftungsziele für die Oberflächengewässer im deutschen Teil der Flussgebietseinheit Elbe für den Belastungsschwerpunkt Schadstoffe. Magdeburg, Germany.

Substances of Concern in the Elbe River Basin



Cd, Hg, Cu, Zn,Pb

As, Dioxin, HCH

HCH, HCB, PCB, DDX, TBT

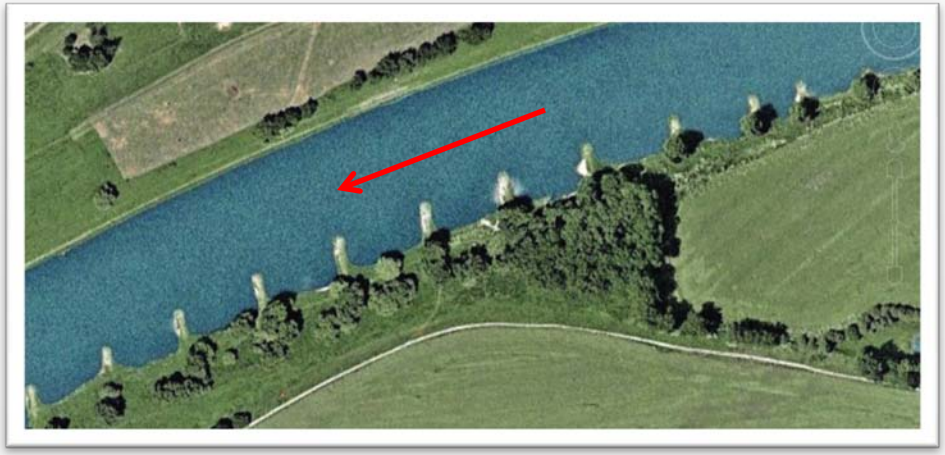
Groyne Fields: Alter the Elbe's Hydraulics

- **History:** Built in 17th century for flood prevention, land acquisition & customs collection
- **Today**: Improve navigability in low water
  - KM 0-~125: No groynes
  - KM >~125: 6900 groynes (**92% of banks**)
- **Assumptions:**
  - Groynes trap fine sediment
  - High water: mobilize fines & sorbed contaminants

R. Schwartz, "Geochemical characterisation and erosion stability of fine-grained groyne field sediments of the Middle Elbe River," *Acta hydrochimica et hydrobiologica* 34, no. 3 (2006).

Role of Groyne Fields in Sediment Transport?

- **Field :** Very little fine sediment in groyne fields (upstream of Magdeburg)
- **Modeling:** Groynes fill quickly with fine sediments

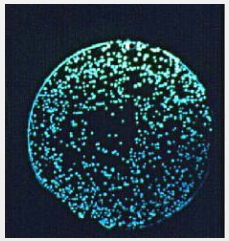


- **Data**:
  - Field Summer 2010: Toxicity & Chemistry data
    - Wittenberg (km 214) –Magdeburg (km 327)
  - Ongoing: Suspended sediment loads

Sediment Sampling: Targeting Sinks/Sources

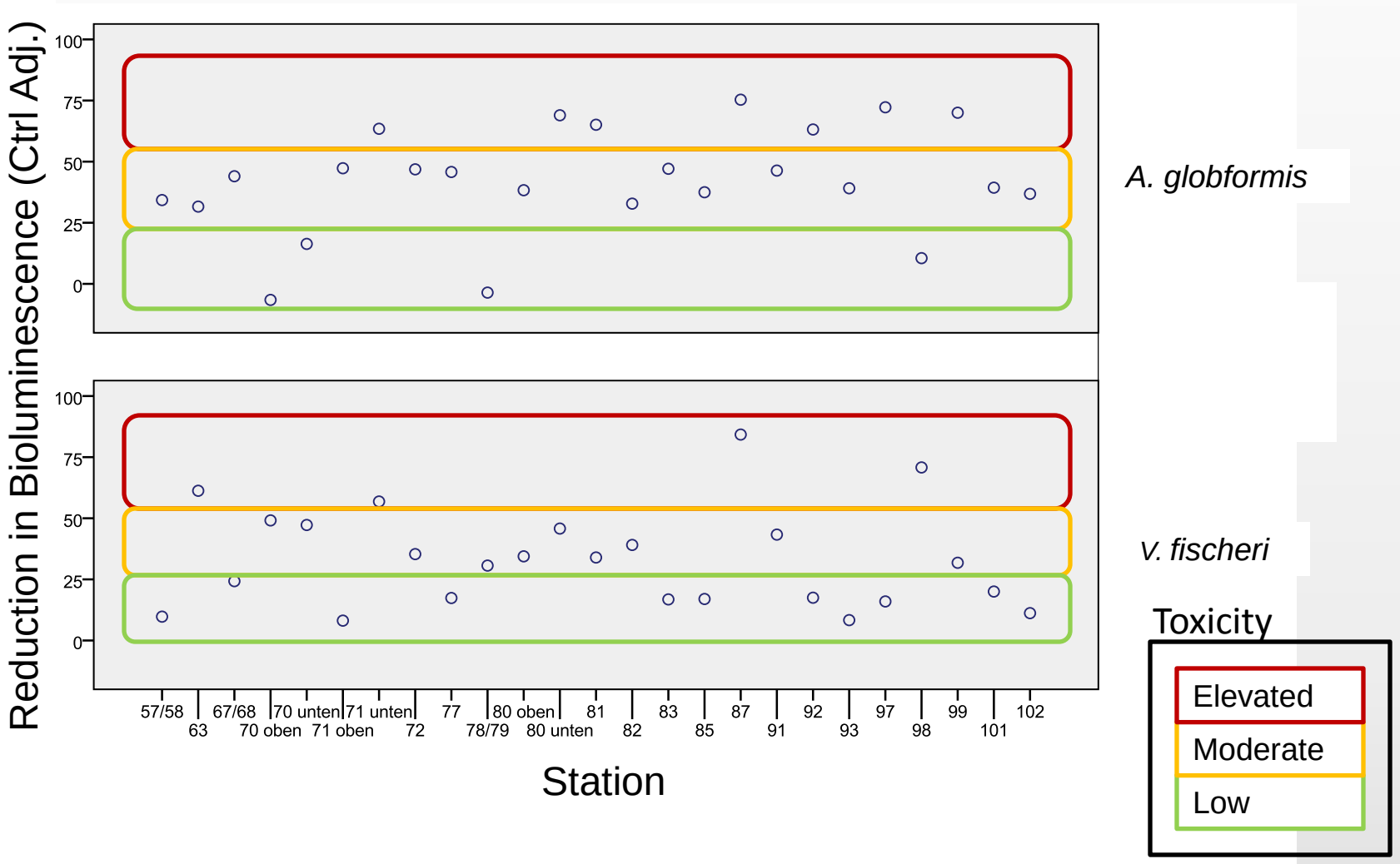
- Sources/Sinks
  - Tributaries (Saale, Mulde)
  - Side-structures
- Sampling Program (n=25)
  - Sediment Chemistry
  - Toxicity:

V. fischeri (Bioluminescent Bacteria)	***A. globiformis*** (Soil Bacteria)
Reduced Luminescence: Evidence of Contamination	Reduced Respiration: Evidence of Contamination
30-Min ElutriateTest	2-Hour Contact Test

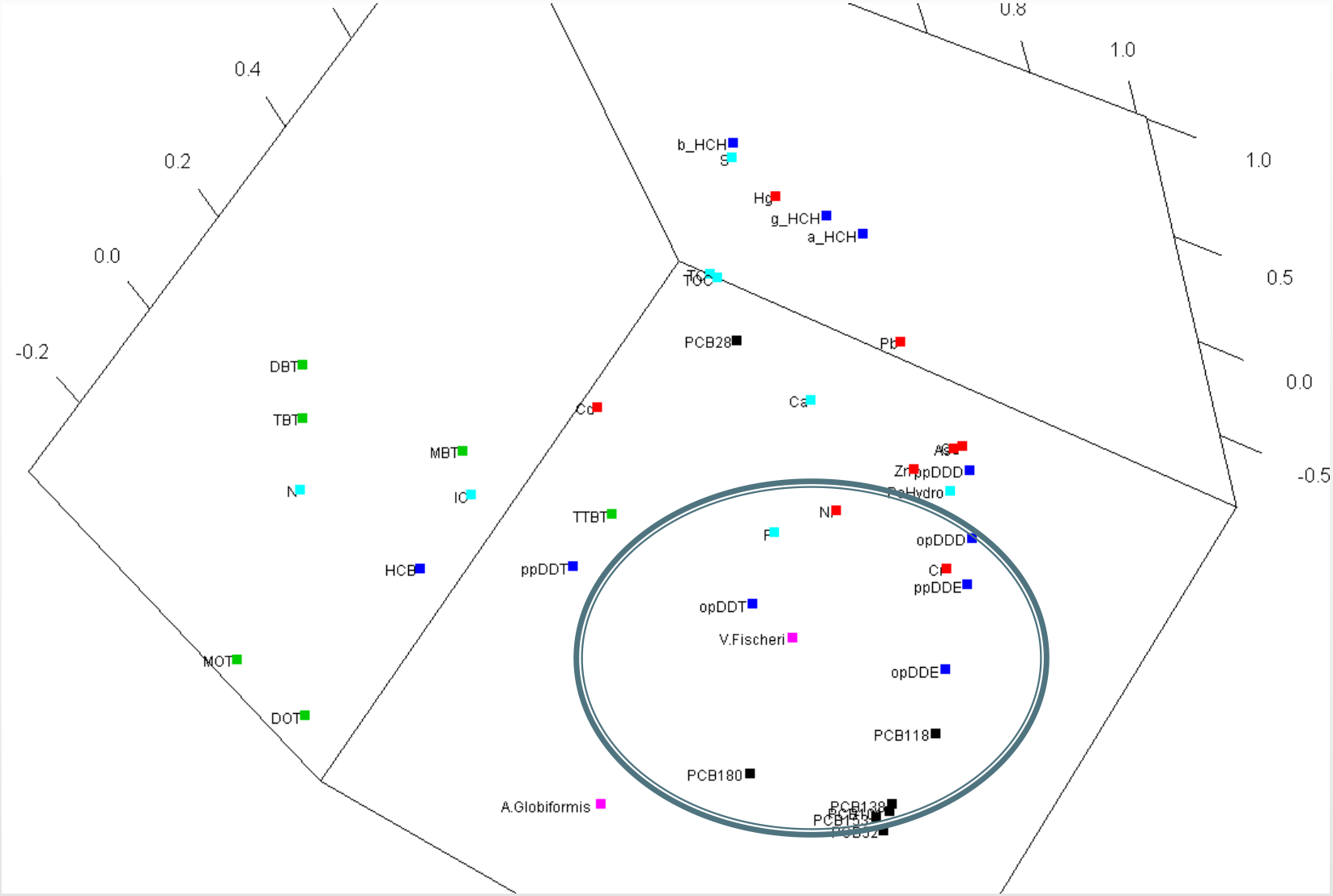


GROYNE FIELDS

Sediment Toxicity: Groynes & Small Harbors

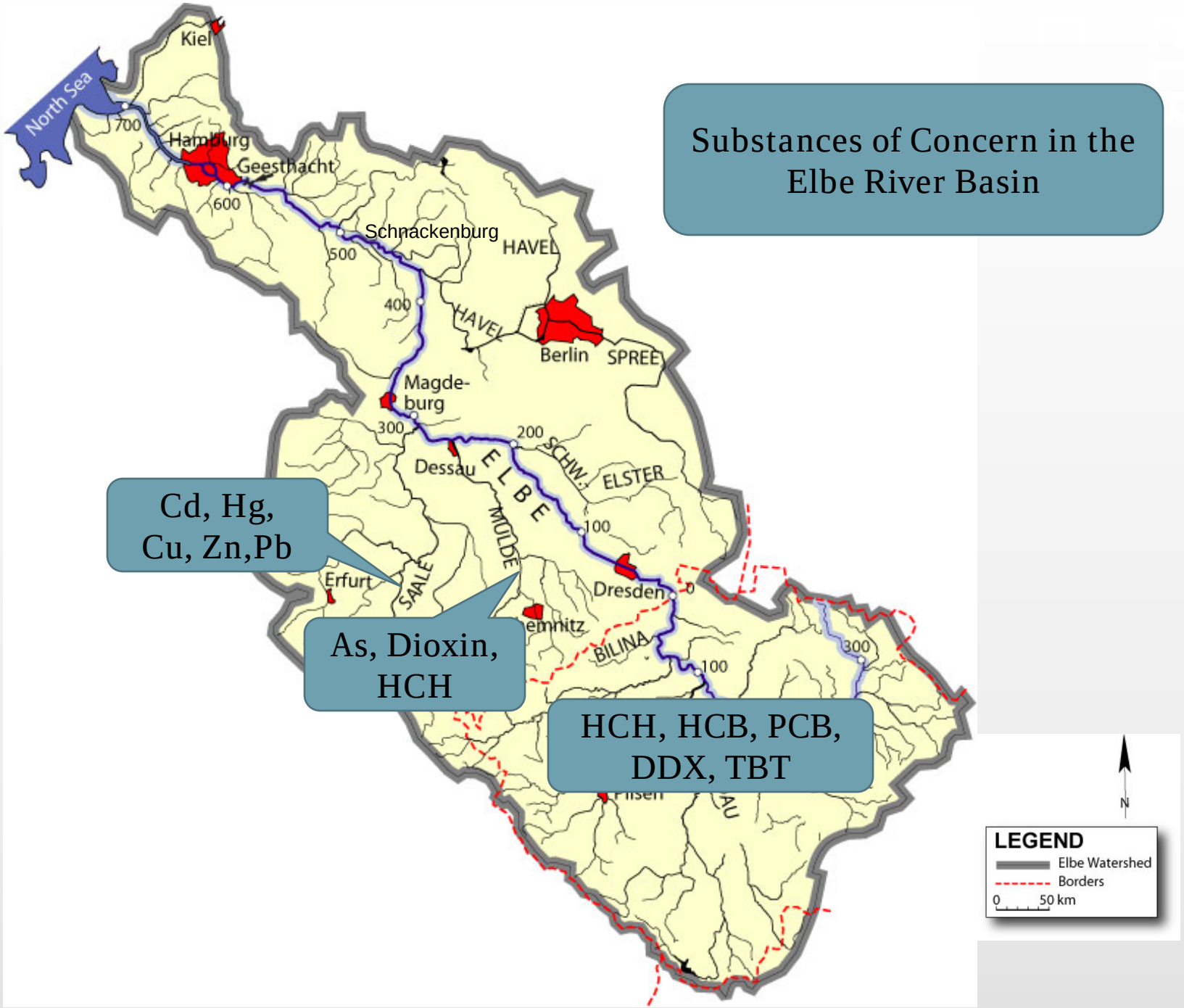


PCA Results : V. Fischeri & Organics



RECENT FIELD DATA

Substances of Concern in the Elbe River Basin



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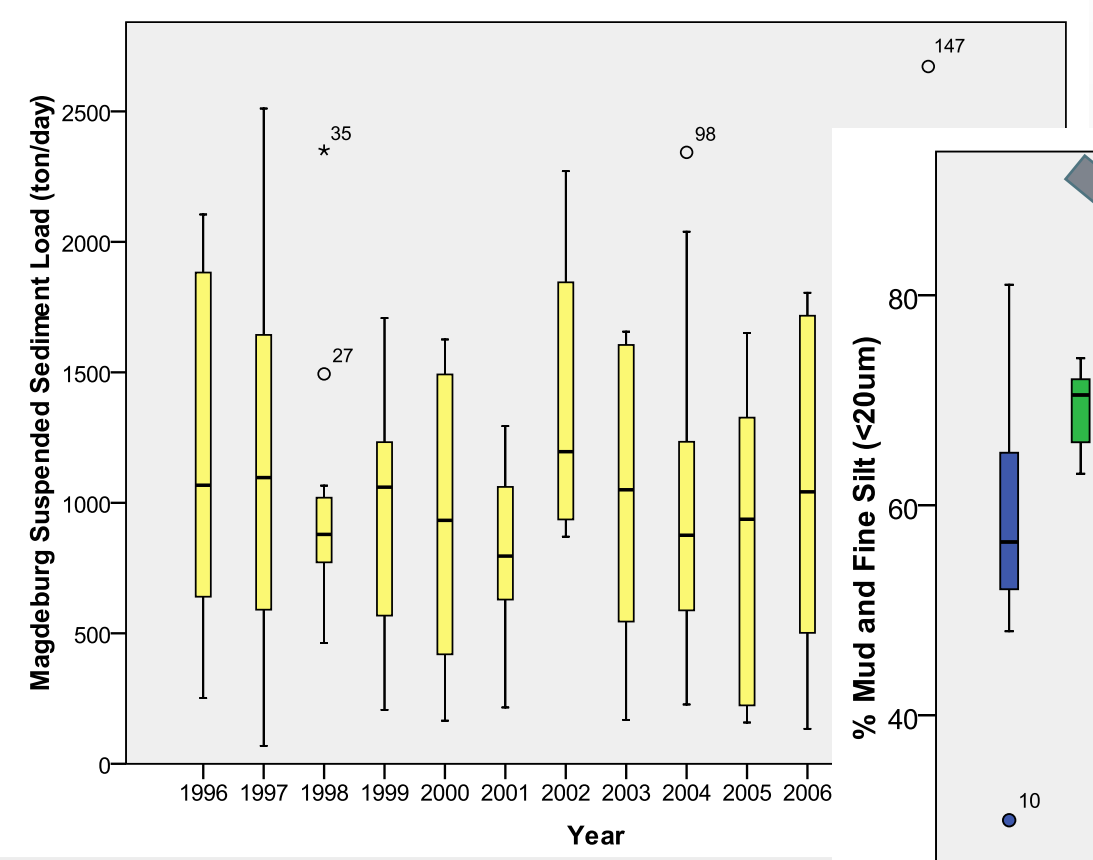
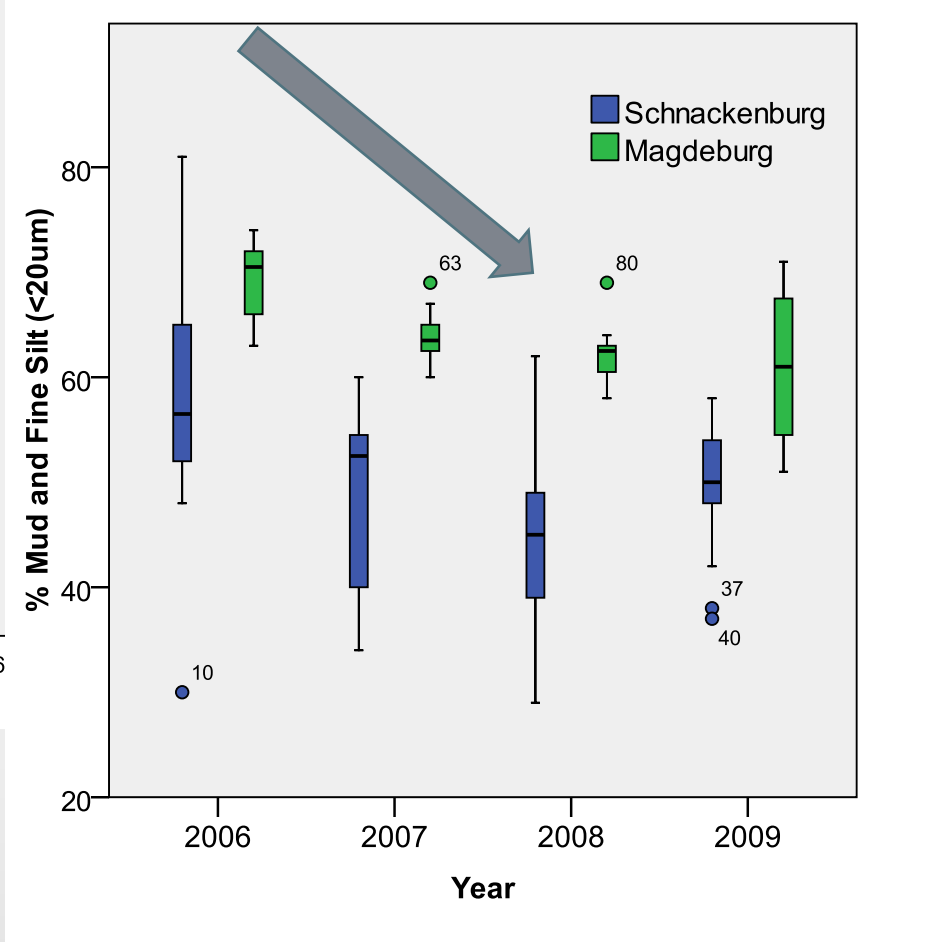
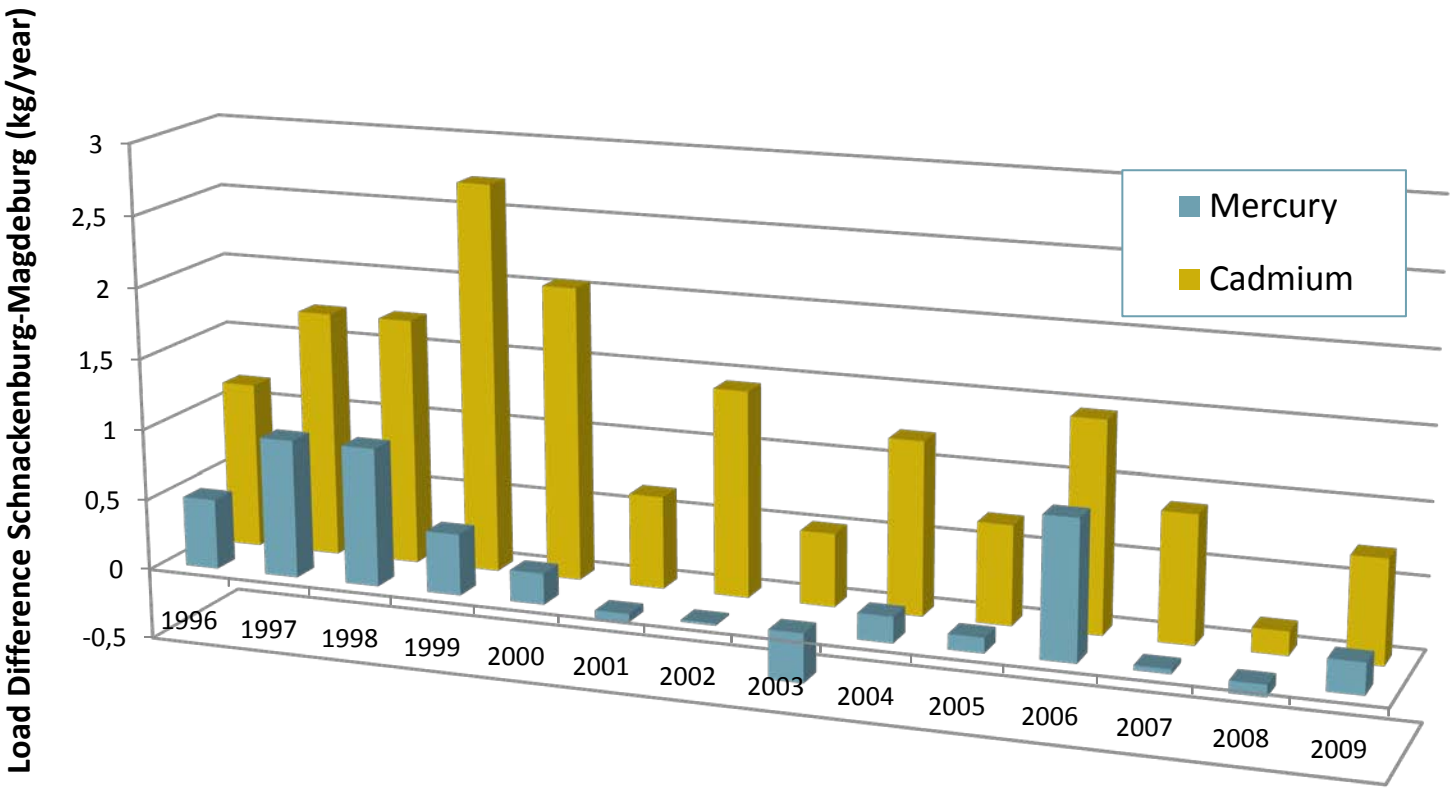
Suspended Sediment Characteristics





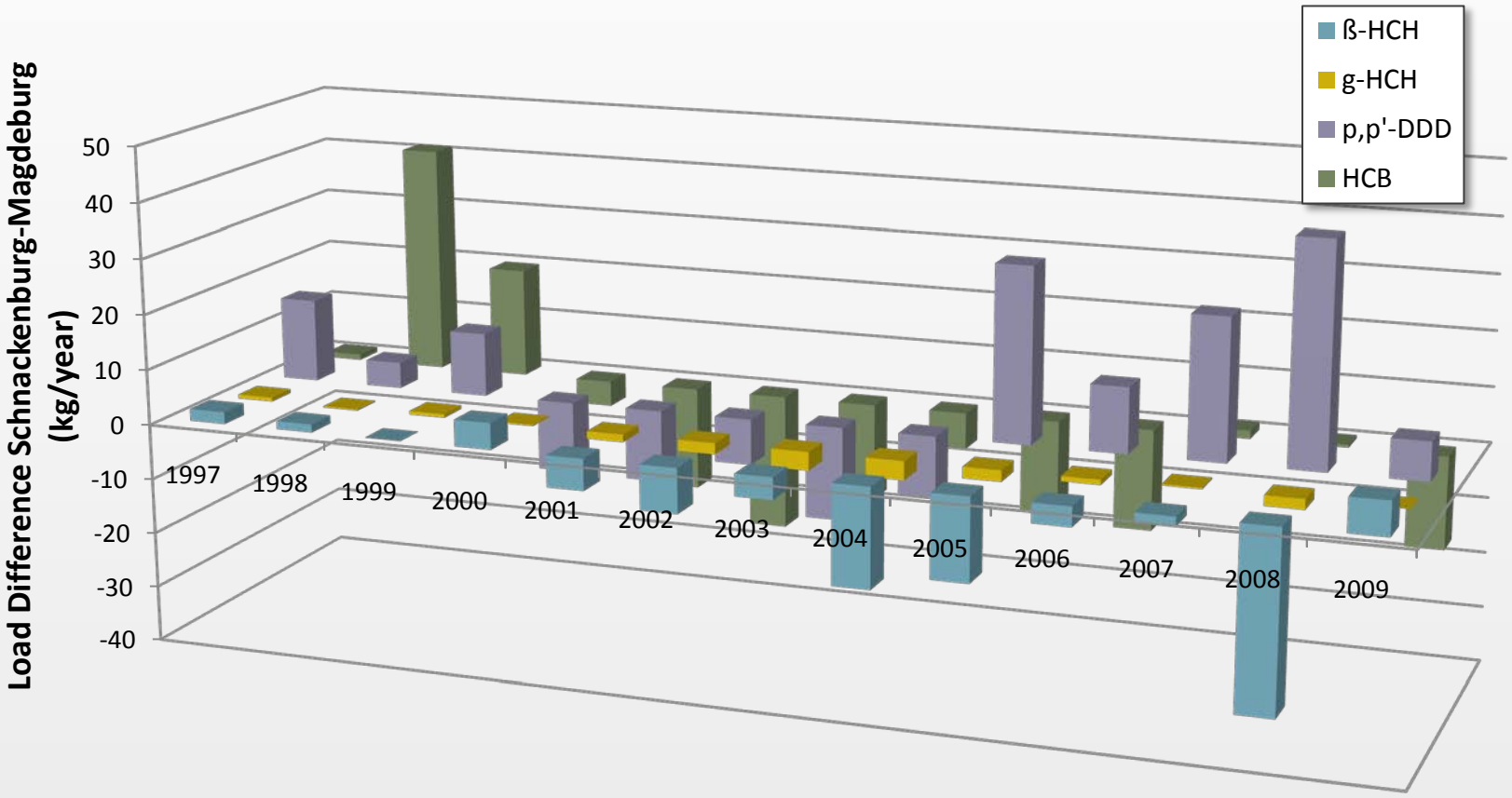
RECENT FIELD DATA

Groynes Likely a Secondary Source



Negative Values: Loads Decrease Downstream
Positive Values: Loads Increase Downstream

Different Sources, Different Processes



Conclusions

- **Coastal Area:**
  - Schnackenburg close to estuary - different contamination patterns
- **Groynes:**
  - Sediments & sorbed contaminants are likely resuspended during high water events (M'burg-S'burg)
  - Sediments are bioavailable and can be toxic (Wittenberg-Magdeburg)
  - Decreased Fines (2006-2008) likely related to coarsening observed in groynes
- **Information Gaps:**
  - More data needed on sediment grain size/density in groynes → To be collected this summer

Thanks for your Attention!

Acknowledgements:

•Michael Bergemann(Behörde für Stadtentwicklung und Umwelt Amt für Umweltschutz Abt.)

Model Elbe hydraulics and suspended sediment -

Czech border–Schnackenburg (km 474.6)

Describe erosion and deposition along and between groyne fields

Estimate transport of particle-bound contaminants – particularly from tributaries

Evaluate multiple scenarios (remediation, floods)