Sediment pollution and its potential toxicity at different trophic levels

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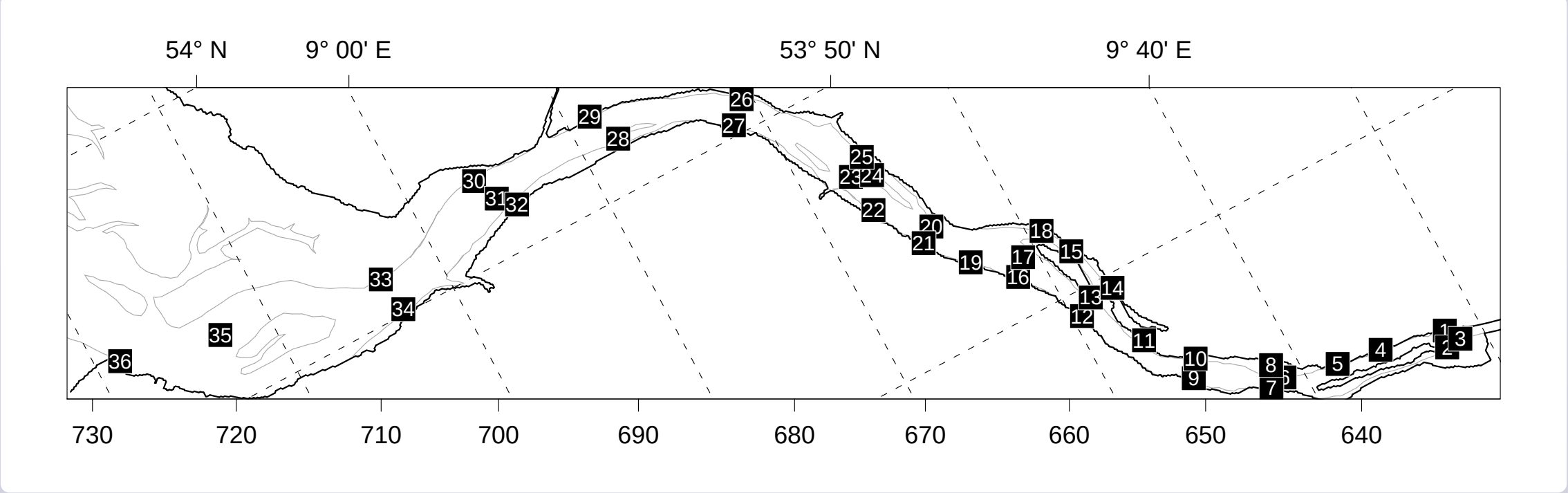
Introduction

- Pollution of aquatic ecosystems poses a serious risk to the aquatic biota.
- Trophic-level-specific Toxic Units (TUs) were proposed to identify the potentially most affected communities [1, 2].
- The maximum TU of the most potent component in the sediment was found to be representative for observed community effects, such as those of pesticides [3–5], industrial chemicals [1, 6] and PAHs [7].
- **Thresholds** for toxic effects of organic pollutants from the literature:
  - **Chronic effects**: $TU > 0.001$ [5, 9, 10]
  - **Acute effects**[11]

in algae:	$TU > 0.1$
in invertebrates:	$TU > 0.01$
in fish:	$TU > 0.1$

Method

- Surface sediments (0-10 cm) were collected at 36 sites in the Elbe estuary.



- Eight heavy metals and 41 organic compounds/sum parameters were analyzed.
- Toxic risks were predicted using the TU approach, based on LC50 values [7, 8] for three **standard test organisms**:

Algae:	*Pseudokirchneriella subcapitata*
Invertebrates:	*Daphnia magna*
Fish:	*Pimephales promelas*

- Maximum TUs were calculated as:

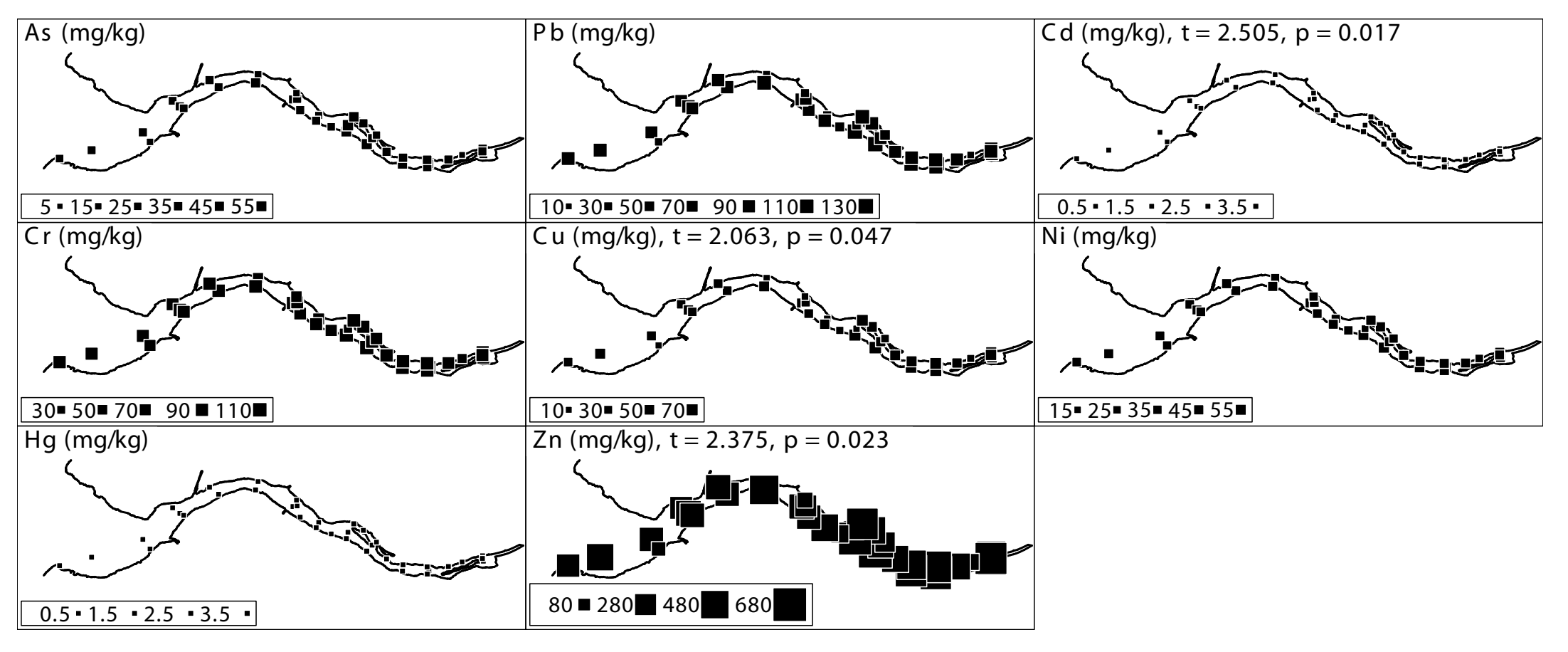
$$TU_{max} = \left(\frac{C_i}{LC50_i}\right)max$$

i is the compound (pollutant), C_i the freely dissolved concentration of i, and $LC50_i$ is the predicted acute lethal concentration in a standard toxicity test.

Conclusion

- The presence of toxic pollutants like TBT and Cu in the sediments, and their predicted influence on the biota might prevent the achievement of the "good" ecological quality status of the estuarine benthos communities according to the WFD.
- This is supported by the observation that today many pollution-sensitive benthos species are lacking in the inner estuary where pollution is more intense [12].

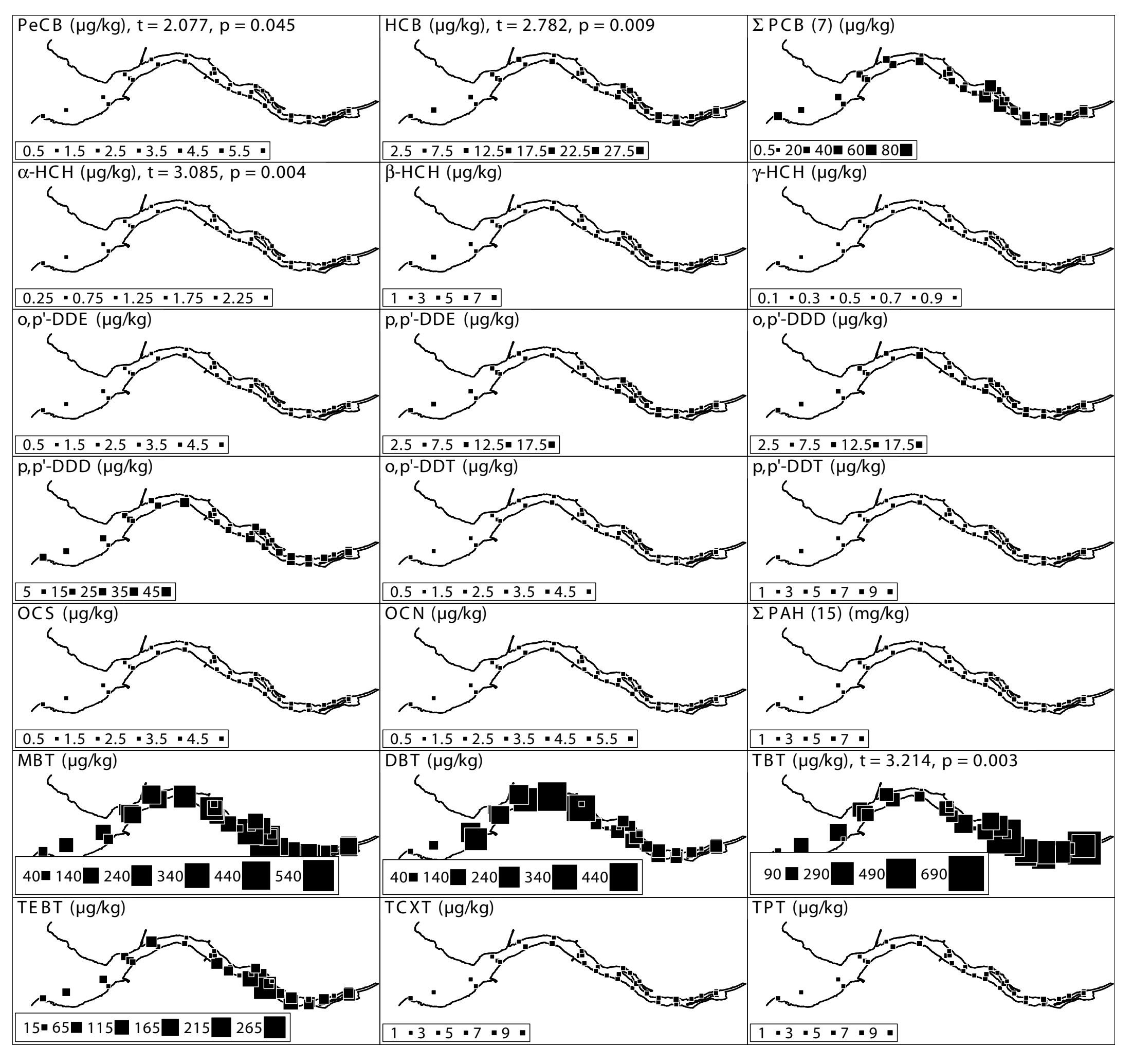
Metal pollution



- All heavy metals, except Cr, decreased in concentration towards the estuary mouth.
- This decrease was significant with Cd, Cu, and Zn.

Cu was identified as the inorganic substance most toxic to invertebrates.

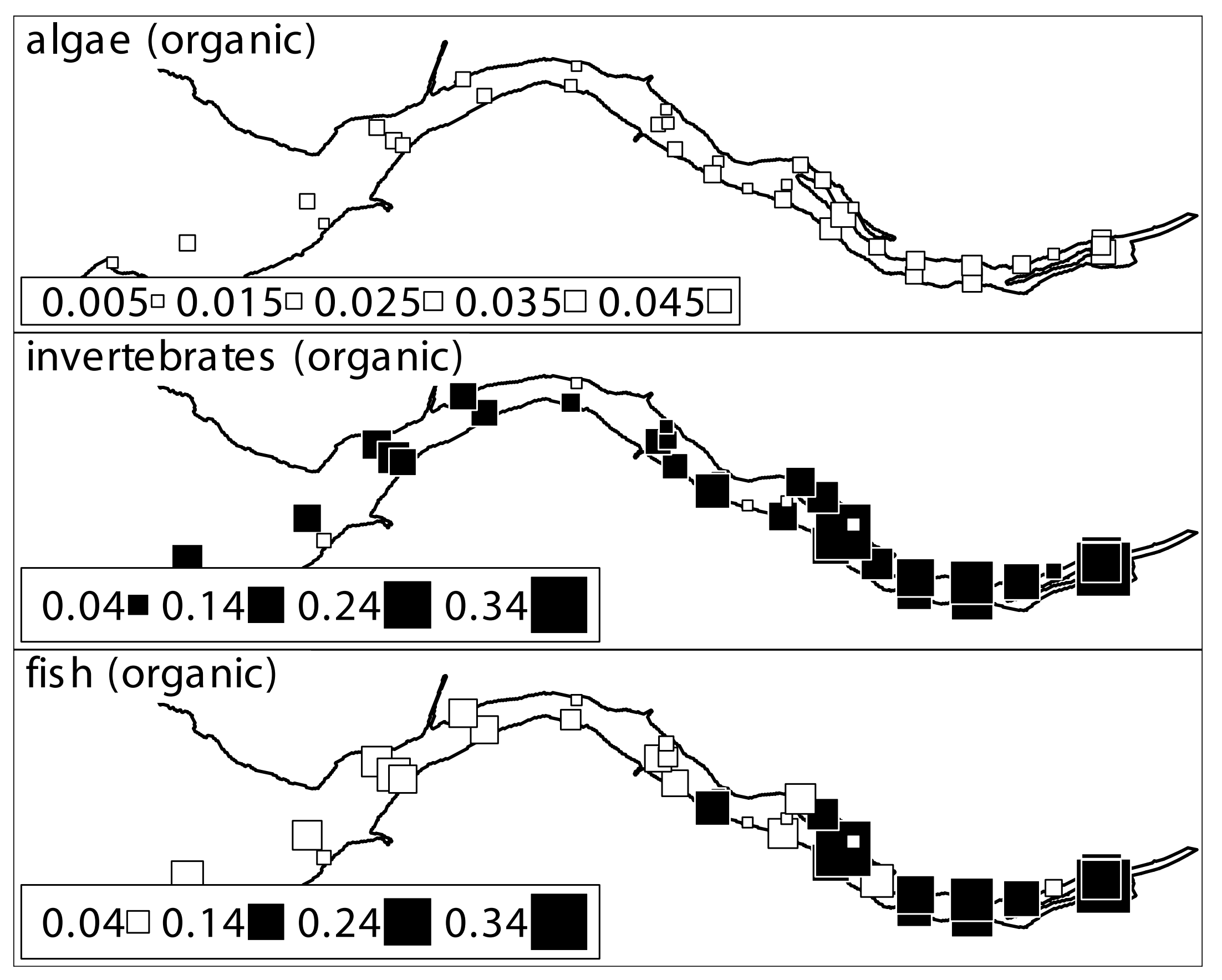
Organic pollution



- Organic pollutants decreased towards the river mouth, except the TBT degradation product DBT.
- Significant changes (decreases towards the river mouth) were observed with PeCB, HCB, α-HCH, and TBT.

TBT was identified as the organic substance most toxic to invertebrates.

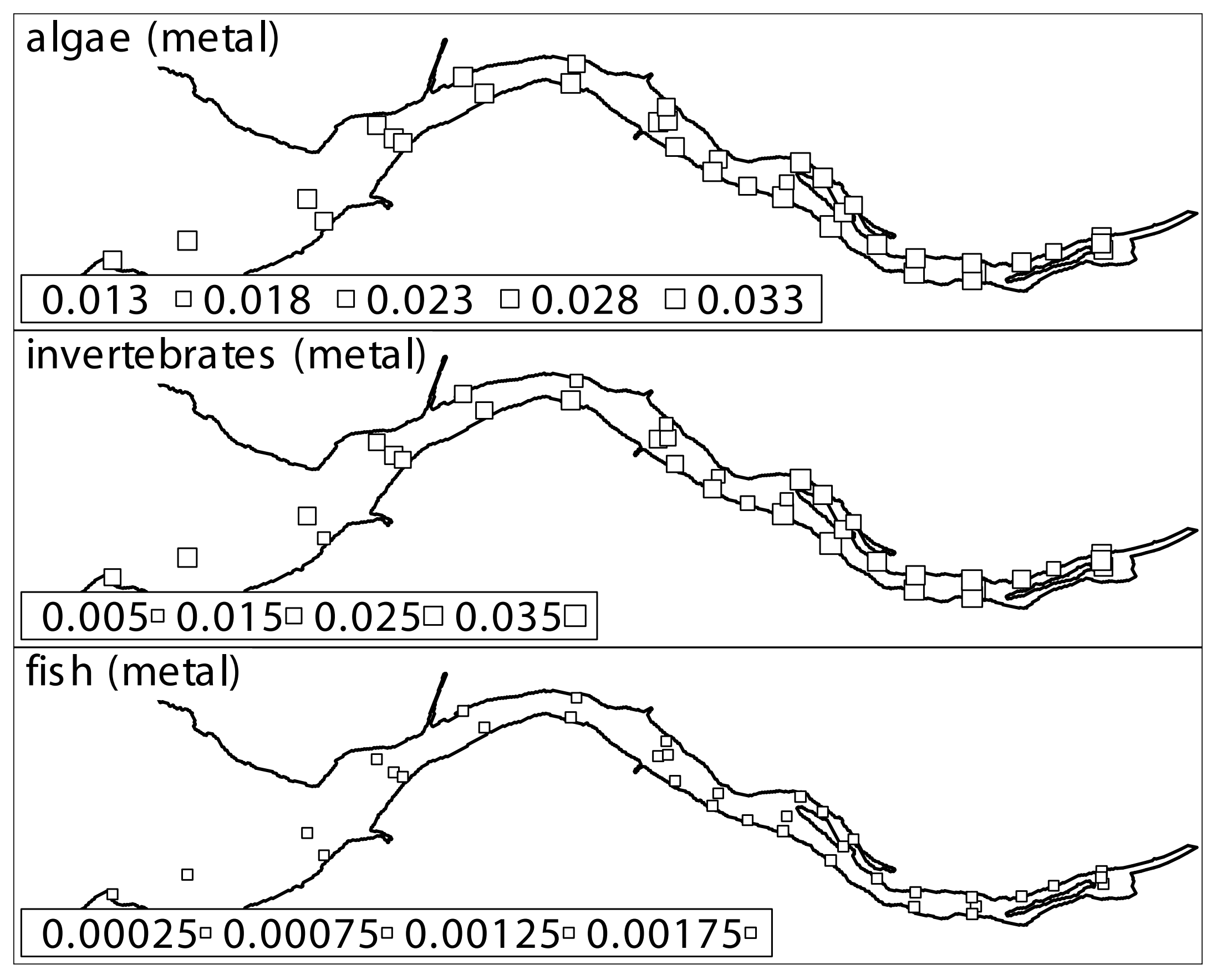
Predicted toxicity (organic)



- Potential acute toxicity of organic pollutants to invertebrates is to be expected at 30 sites ($TUs > 0.01$, black squares).
- Potential acute toxicity of organic pollutants to fish is to be expected at 11 sites ($TUs > 0.1$, black squares).
- Chronic effects to invertebrates ($TUs > 0.001$) are to be expected at all 36 sites.

Organic pollution most likely affects the benthosfauna at all sites investigated.

Predicted toxicity (metal)



- Potential toxicity of metal pollutants is much smaller than that of organic pollutants.
- No thresholds are available for metal toxicity.

Metal pollution has probably the potential to cause chronic effects.

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