

# *A sensitive integrated approach to assess sediment quality: application to a low contamination case study (Minho River)*

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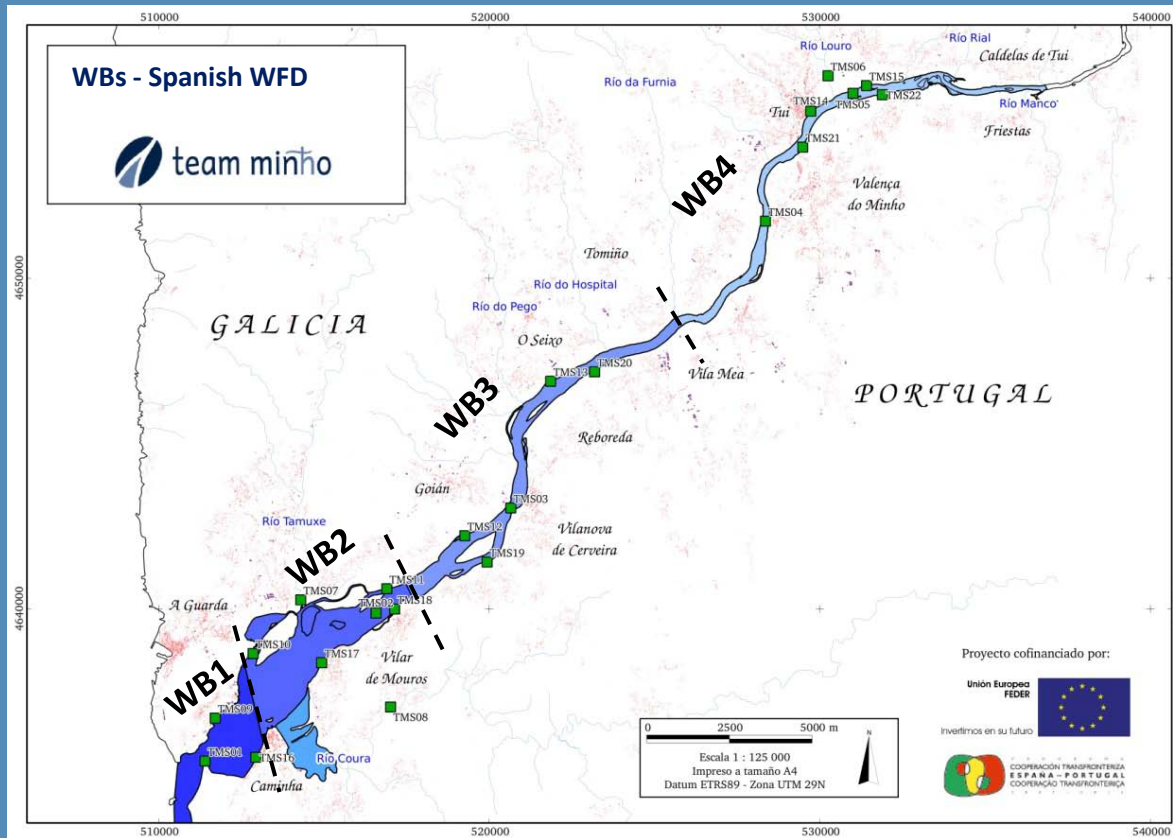
# Introduction

- Sediment quality is crucial for the aquatic ecosystem functioning
- How to assess sediment quality?
  - Chemical parameters
  - Responses of organisms to contaminants
  - Use of ecotoxicological assays
- This approach has been mainly used in contaminated sediments

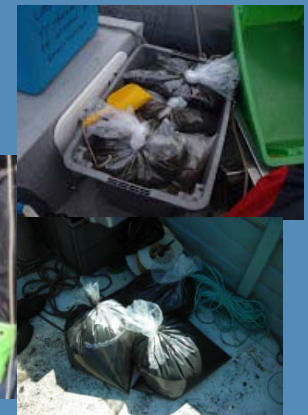
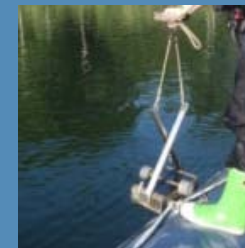
*Do ecotoxicological assays respond to low contaminated systems?*

*Are ecotoxicological assays more sensitive than chemical parameters to assess sediment quality?*

# Study area and Sampling



Twenty two surface sediment samples collected along the Minho River estuary



# Analytical methods: Trace elements

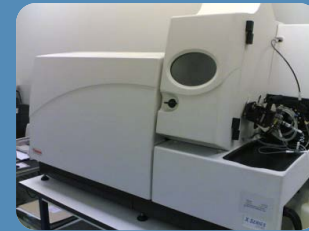
## Samples

- Sediment samples were dried
- Grounded in agata mortar
- Digested with different acids



## Chemical analysis

- Determination by ICP-MS:
  - Al, As, Cd, Co, Cr, Cu, Ni, Pb and Zn
- Determination by thermal decomposition AAS:
  - Hg



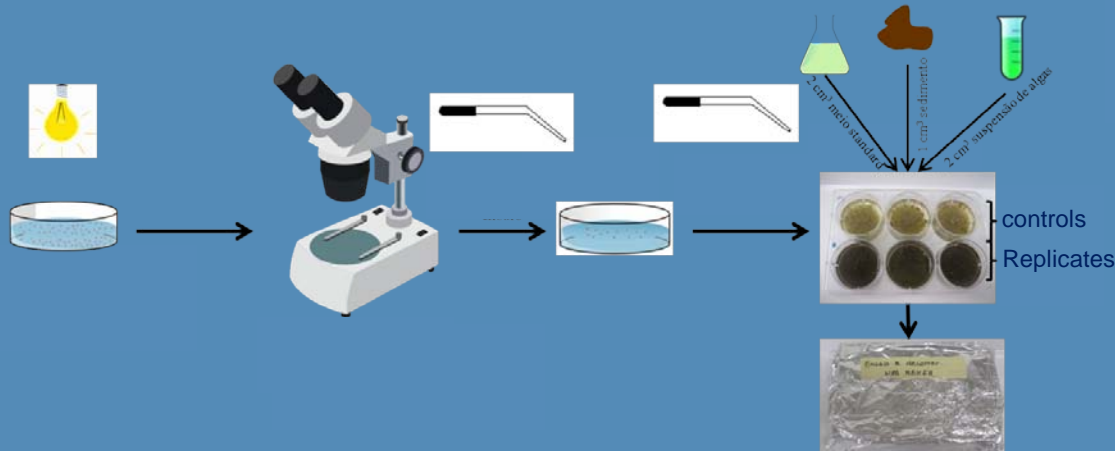
# Analytical methods: ecotoxicological assays

## Microtox assay with bacteria - *Vibrio fischeri* (decomposer)



- 15 minutes exposure to evaluate bioluminescence inhibition

## Mortality and growth endpoints with ostracods - *Heterocypris incongruens* (primary consumer)



- 72 hours exposure to evaluate mortality and growth inhibition

# Analytical methods: ecotoxicological assays

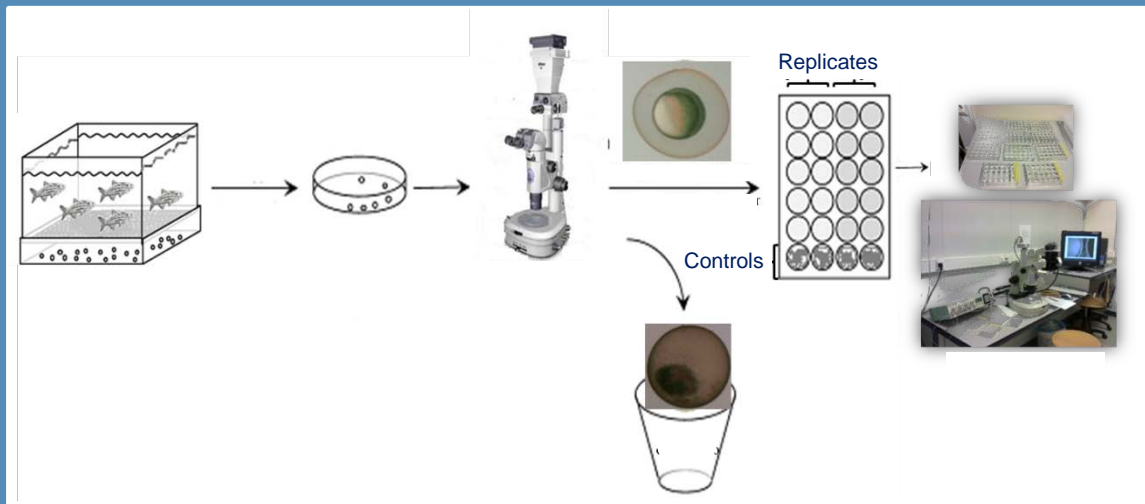
## Growth inhibition with green microalgae – *Pseudokirchneriella subcapitata*

(primary producer)



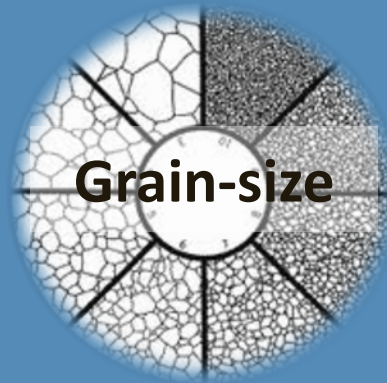
- 72 hours exposure to evaluate growth inhibition

## Embryonic development with fish – *Danio rerio* (secondary producer)

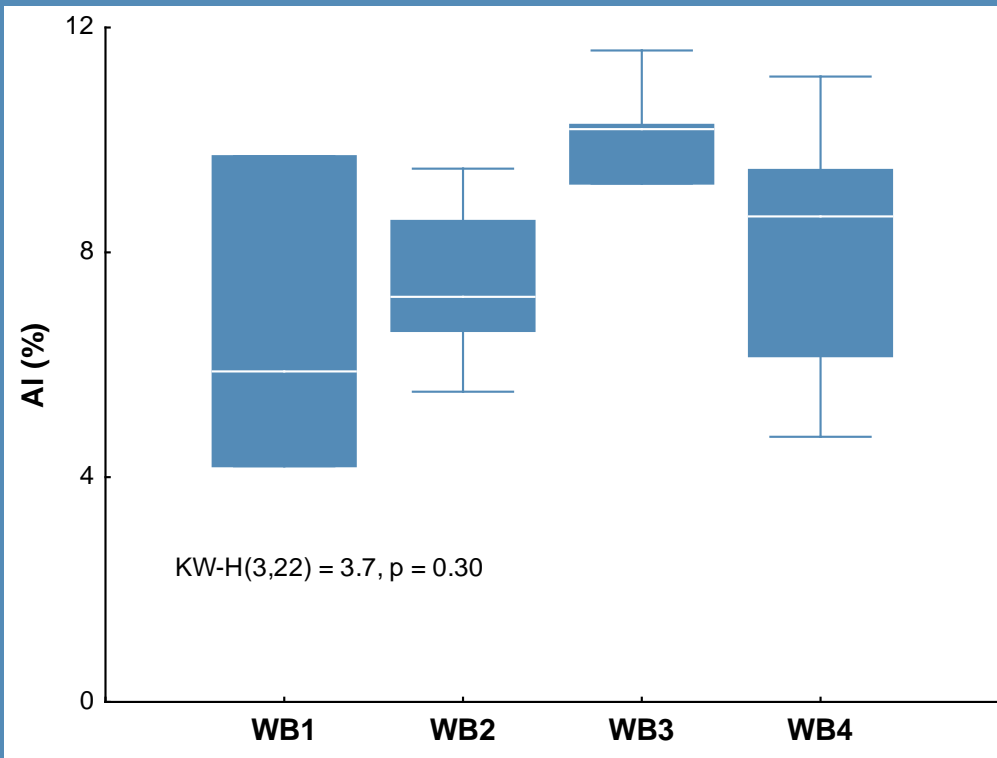


- 96 hours exposure of to evaluate embryonic development (heart beats/10 s) and mortality

# Sediment Quality is influenced by



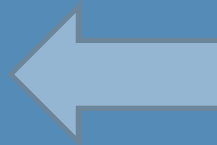
# Results: Grain-size composition



Variability of grain-size distribution along 4 Water Bodies (WBs) of Minho Estuary (AI used as proxy)

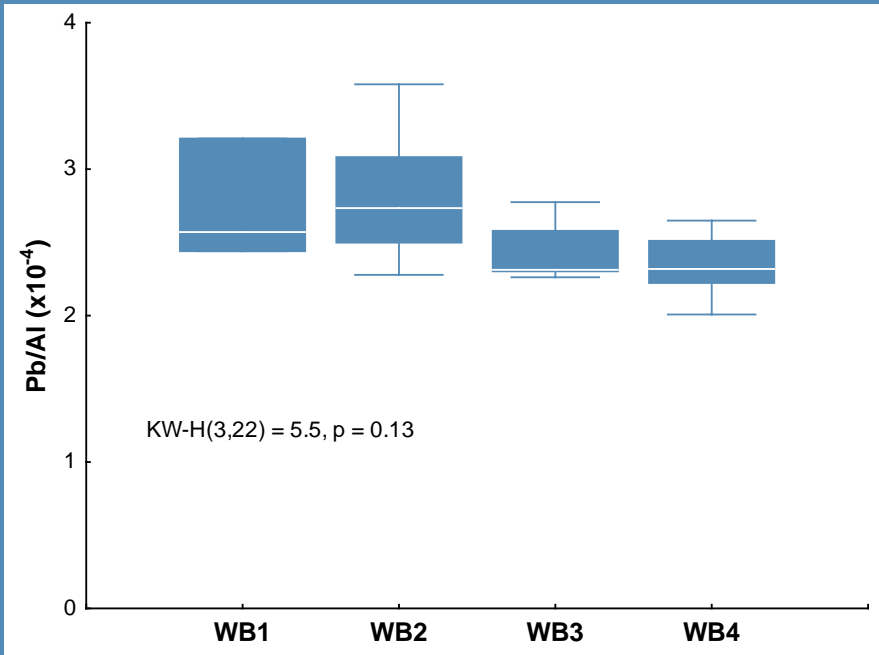


**Sediment composition normalized to AI**  
(minimize grain-size variation)





# Results: Metal/Al ratios – lithology or pressures?



Similar Pb/Al ratios along the estuary

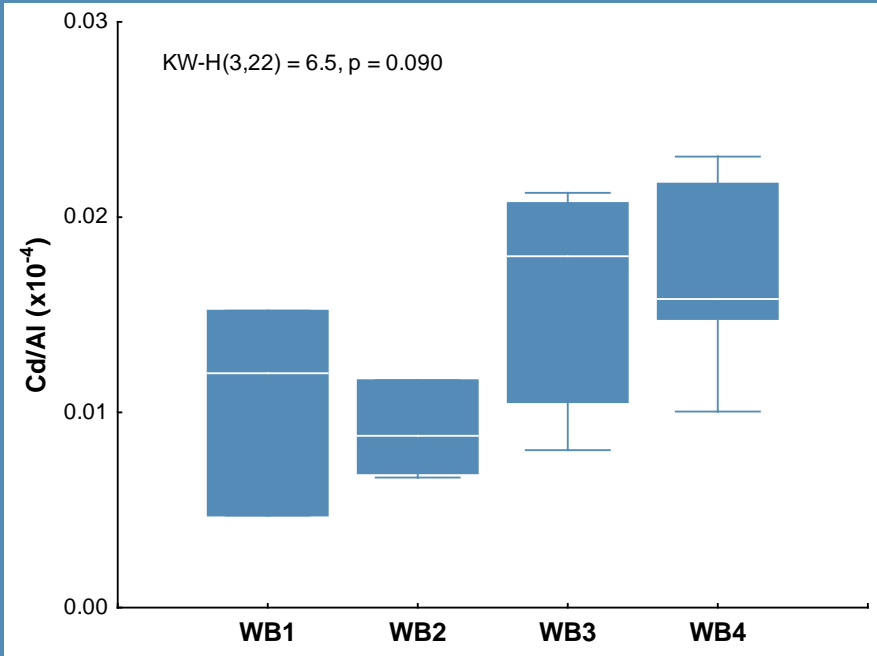
No evidence of



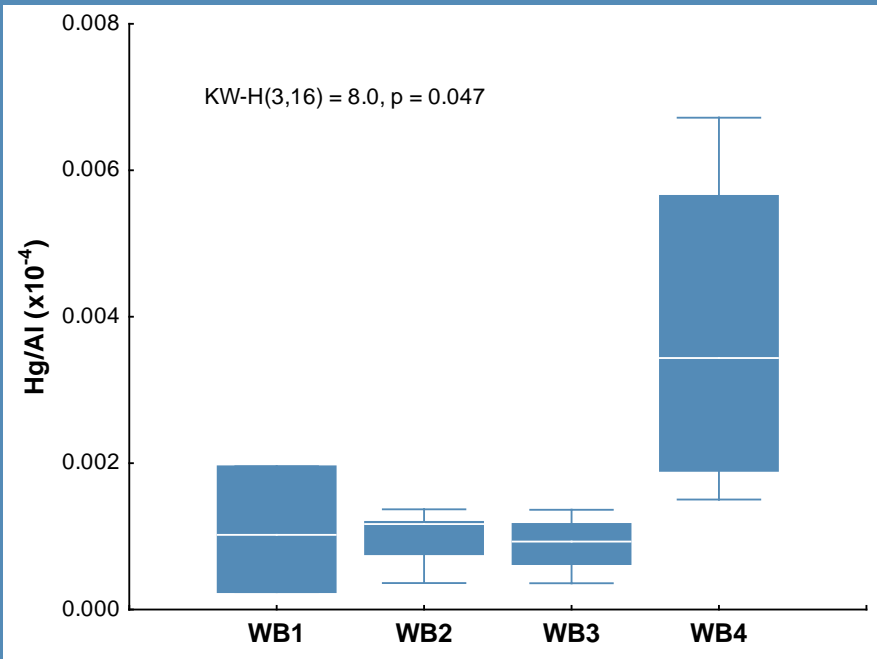
Median Cd/Al ratios higher in WB3 and WB4



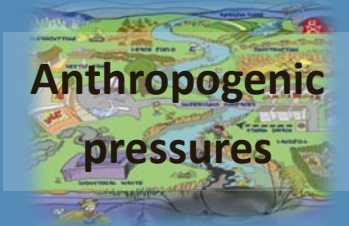
?



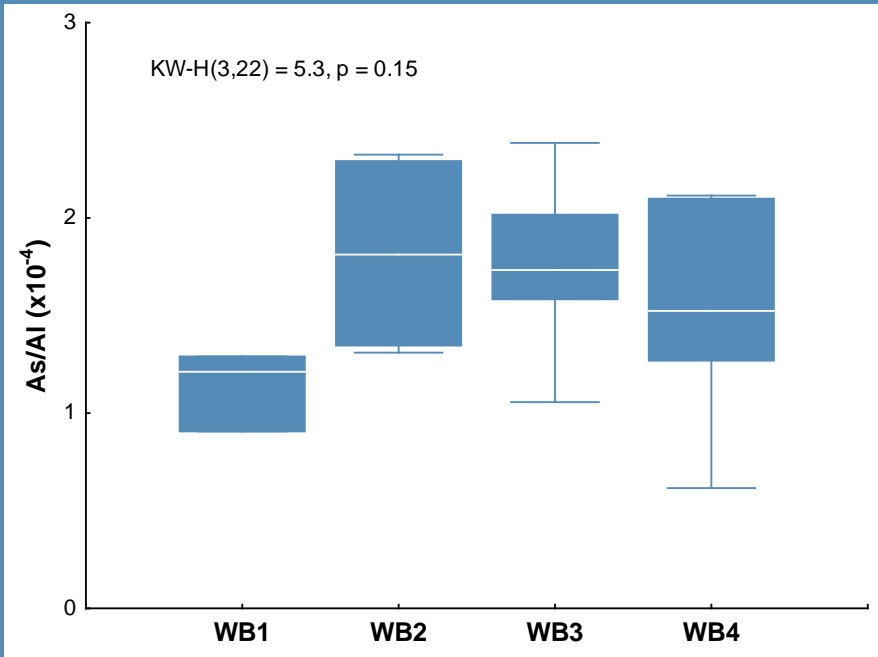
# Results: Metal/Al ratios – lithology or pressures?



Enhanced Hg/Al ratios in WB4



Higher median As/Al ratios in WB2, 3 and 4



# Results: Comparison of metal concentrations with SQGs

## Comparison of 90<sup>th</sup> percentile

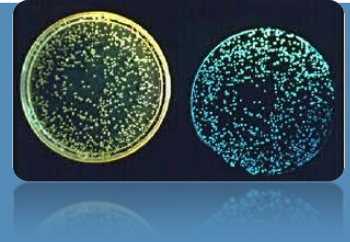
### Sediment Quality Guidelines

<b>Benchmarks</b> <i>(90<sup>th</sup> percentil)</i>	<b>As</b>	<b>Cd</b>	<b>Cr</b>	<b>Cu</b>	<b>Hg</b>	<b>Ni</b>	<b>Pb</b>	<b>Zn</b>	<b>tPCB</b>
	$(\mu\text{g g}^{-1})$								$(\text{ng g}^{-1})$
WB1									
WB2									
WB3									
WB4									
ERL	8.2	1.2	81	34	0.15	21	47	150	0.023
ERM	70	9.6	370	270	0.71	52	218	410	0.18

**ERL** – Effects Range-Low; **ERM** – Effects Range-Median

**Above the guideline values: As (all WBs), Ni (WB4)**

## Results: bioluminescence inhibition (*Vibrio fischeri*)

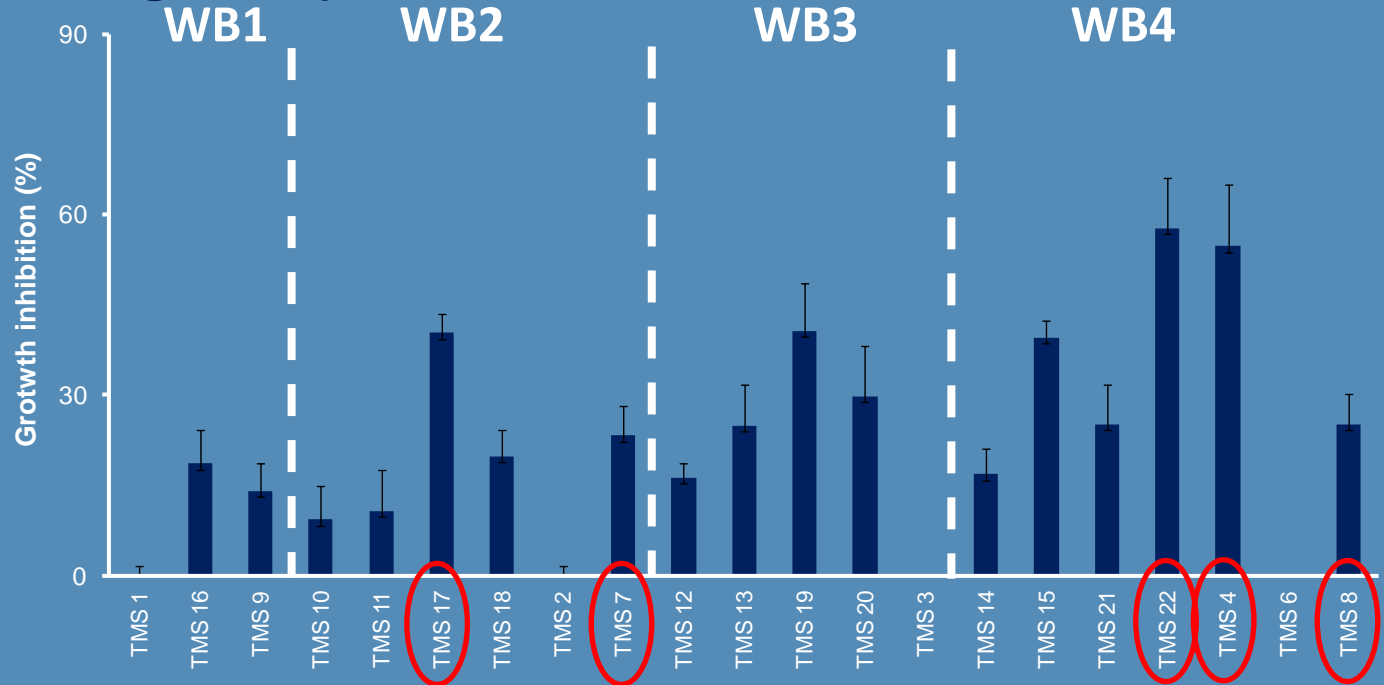


- ❖ No significant effects were observed for the bioluminescence production of the bacteria *Vibrio fischeri* after exposure to sediments

# Results: Growth inhibition and mortality (*Heterocypris incongruens*)

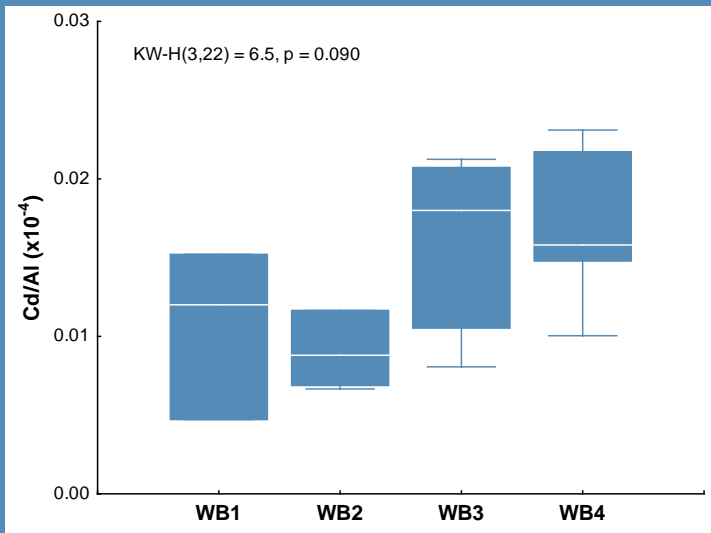


*Heterocypris incongruens*



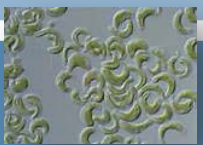
**Mortality higher  
Higher growth  
inhibition and  
mortality in the  
WB4**

TMS4 - 70%  
TMS8 - 37%

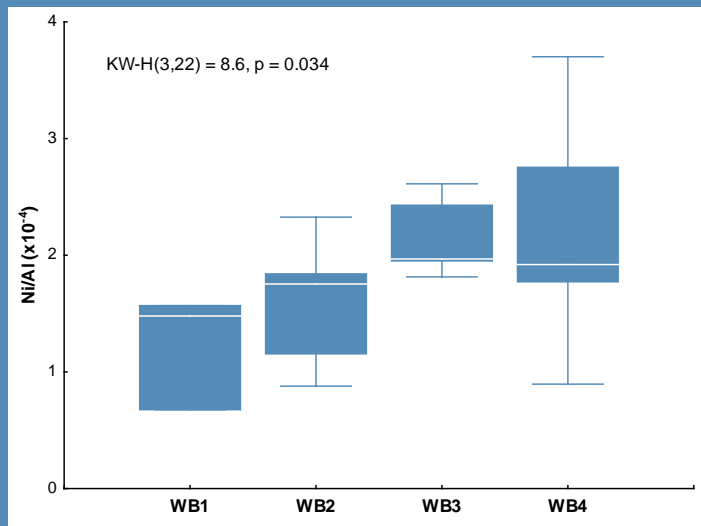


**Are organisms responding to  
enhancement of metal availability?  
e.g., Cd and Hg**

# Results: Growth rate *Pseudokirchneriella subcapitata*

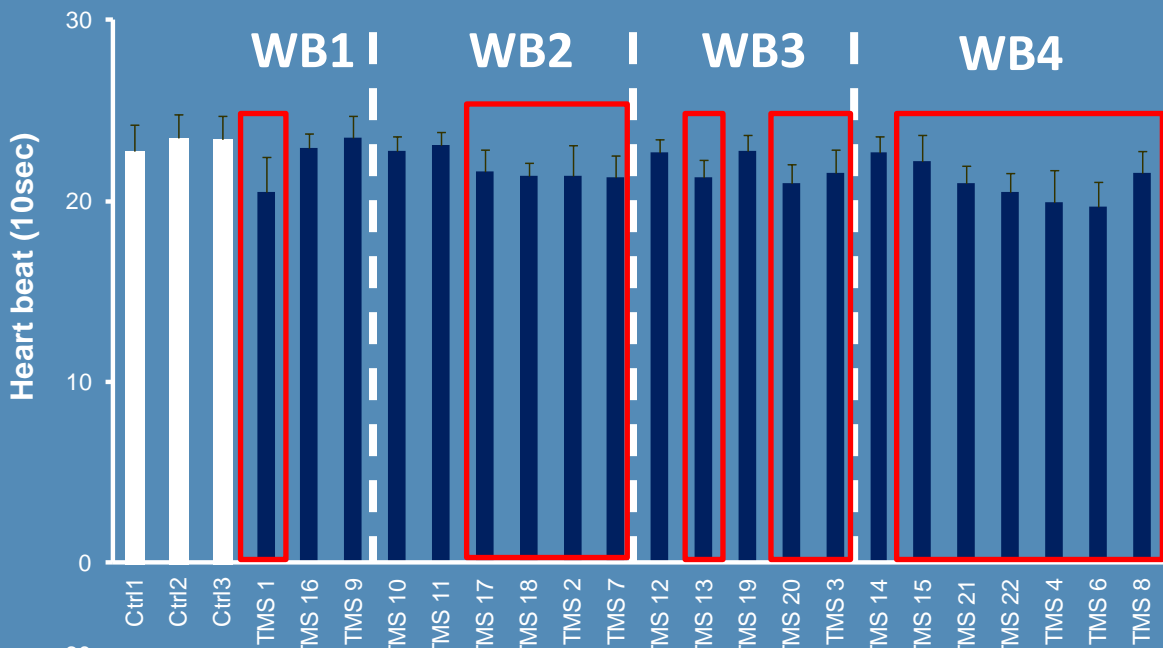
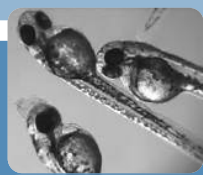


**Comparison to control:  
lower growth rates in  
samples from WB3 and  
WB4**

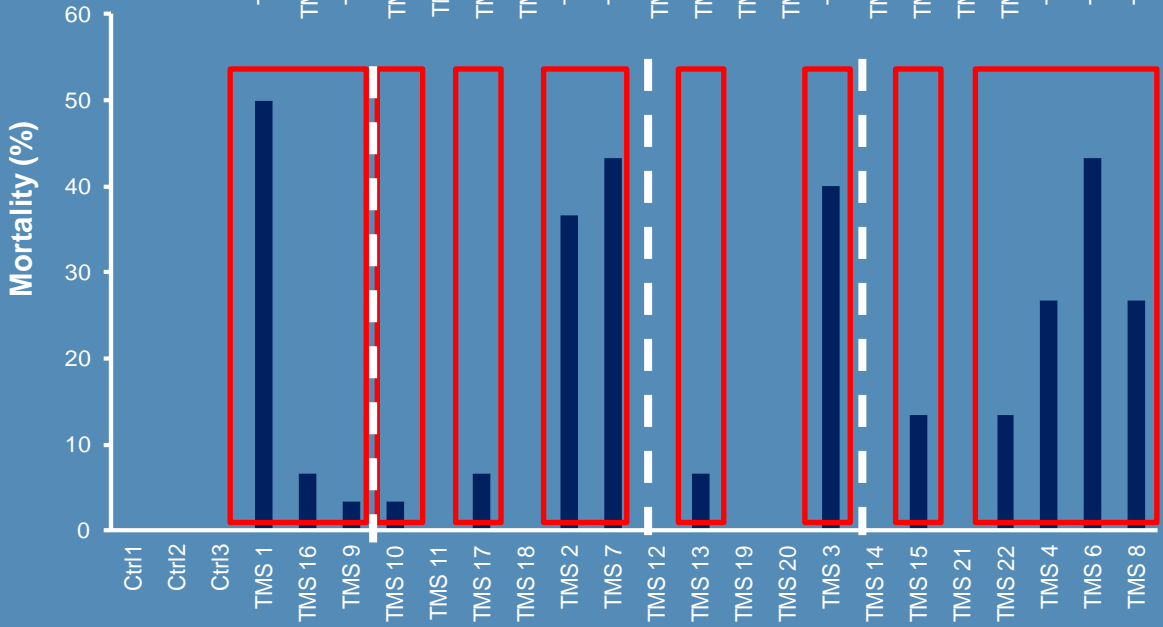


**Is growth rate affected by metal(s)  
present in the sediment?**

# Results: Embryonic development *Danio rerio* (heart beat, mortality)

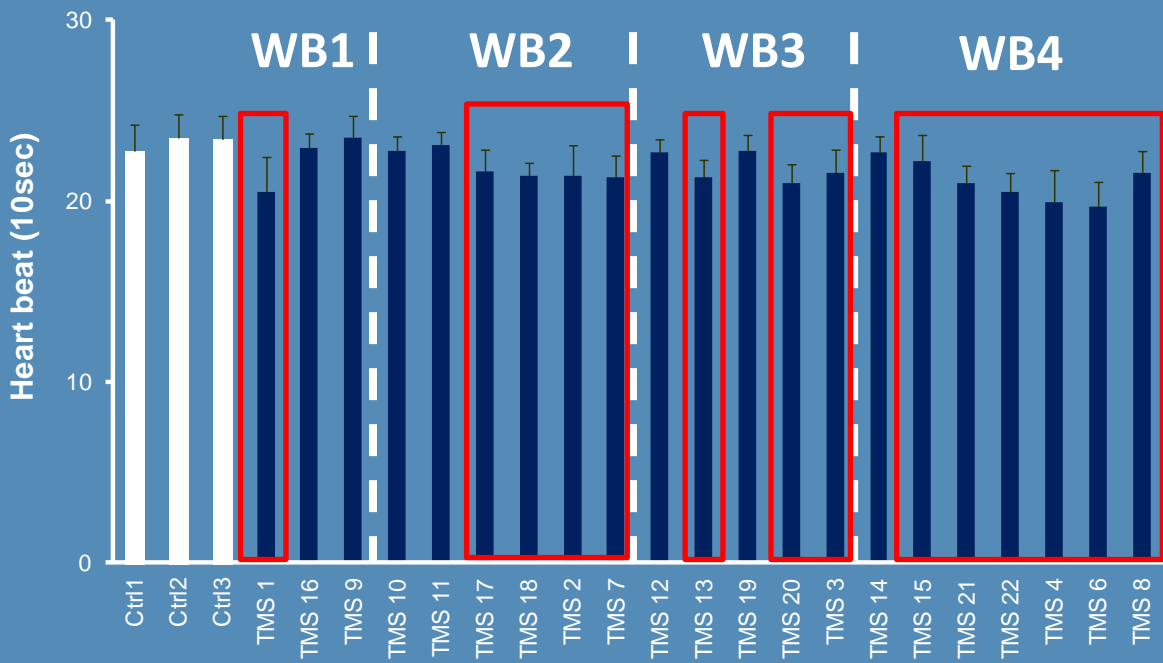
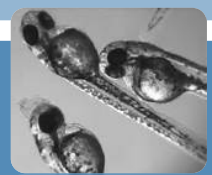


**Comparison to control:  
Lower heart beat was  
observed in all WBs**



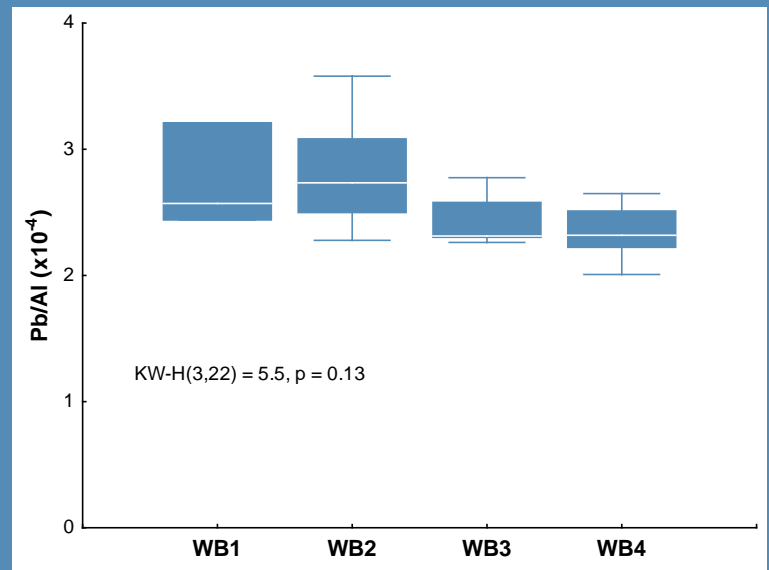
**Mortality was  
observed in all WBs**

# Results: Embryonic development *Danio rerio*



High effects on embryonic development and mortality in all WBs

Are organisms responding to metal(s) present in the sediment?





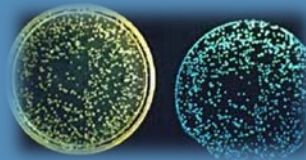
# Final remarks

Low metal concentrations in sediments (except As)



Minho estuary

No responses were observed for the bioluminescence production of the bacteria



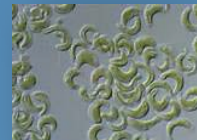
*Vibrio fischeri*

High growth inhibition and mortality found for the ostracods in WB4



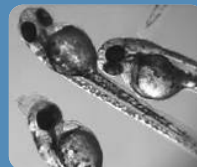
*Heterocypris incongruens*

Lower growth rates in WB3 and WB4 in green microalgae



*Pseudokirchneriella subcapitata*

Effects on heart beat and mortality of fish (larvae) in all WBs



*Danio rerio*

Low impacted system



Presumably, organisms respond to the presence of contaminants



Natural system  
Synergetic relations  
Other contaminants

**Important to use ecotoxicological indicators as a complement of chemical indicators to assess sediment quality**

**Thank you**

