



# Development of a Triad assessment method for brackish and saline sediments in Flanders

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# Sediment Quality Triad Assessment

- Sediment Quality Triad approach (*Long and Chapman, 1986 (USA – Canada)*): Integrated assessment of sediment quality in aquatic systems based on measures of chemistry (1), ecotoxicity (2) and macrobenthos (biology) (3)



**Chemical analysis**  
Degree and nature of  
pollutant  
contamination



**Ecotoxicological  
analysis**  
Ecotoxicological  
effects (lab tests)



**Biological  
analysis**  
Effects on the  
biological community

No evidence of  
ecotoxicological/  
biological effects

No evidence of  
biological effects  
in the field



# Sediment Quality Triad Assessment

- Flanders: Flemish Environment Agency (VMM): sediment quality triad assessment method → evaluation of freshwater sediments
  - Factor of salinity, lower macrofauna diversity, ecotoxicological tests are carried out with freshwater species, ...
- need for **adapted triad assessment method for brackish and saline environments**



# Setting sediment quality ranges



## Triad method for freshwater sediments

- 12 reference waterways in Flanders

## Adjustment of micropollutant quality ranges

- Application of Flemish ecotoxicologically and ecologically based SQGs (*de Deckere et al., 2011*) (PCBs, OCPs, EOX, Mineral oil)
- **Additionally: review of published SQGs** (freshwater and estuarine/marine guidelines included) (Metals, PAHs, TBT)
- **Indicating preliminary quality ranges for micropollutant concentrations**

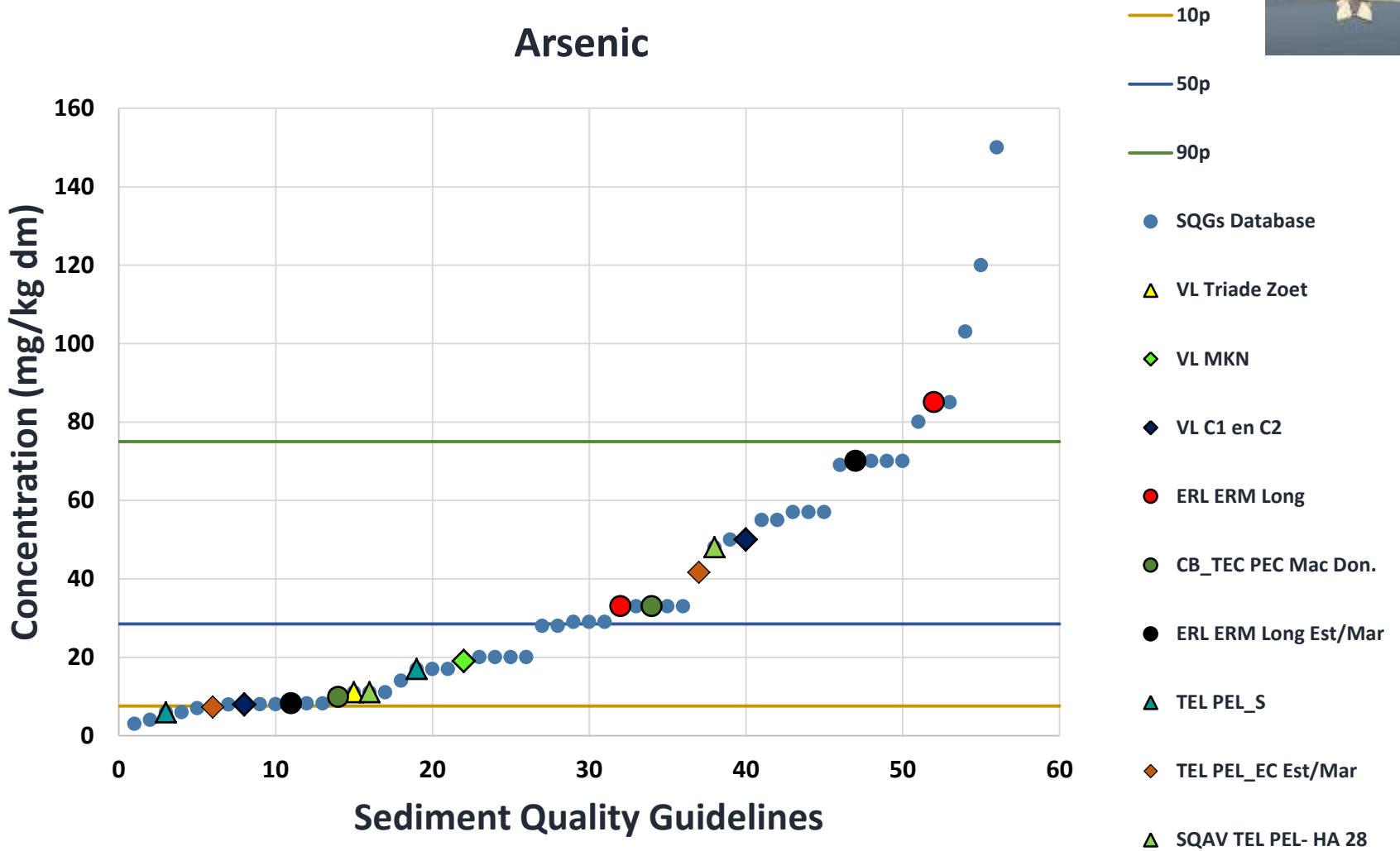
## Way Forward

- Expanding Flemish brackish/saline ecotox and biology database  
➔ **derivation of Flemish SQGs based on brackish/saline systems**

# Setting Sediment Quality Ranges



## Arsenic





# Selecting Bioassays



## Relevant properties for the selection of test organisms

Eat direct and frequently detritus and sediment

Tolerate broad range of salinity

Existing experience with organisms in bioassays

Native species/ecological relevance

Suitable for bioaccumulation measurements

## Relevant criteria for the selection of bioassays

Salinity range

Pathways of exposure

Ecological relevance

Acute or chronic tests

≠ Taxonomic groups represented

Practical feasibility

Degree of standardization

# Selected Bioassays



10d sediment contact test with *Corophium volutator* (mortality)

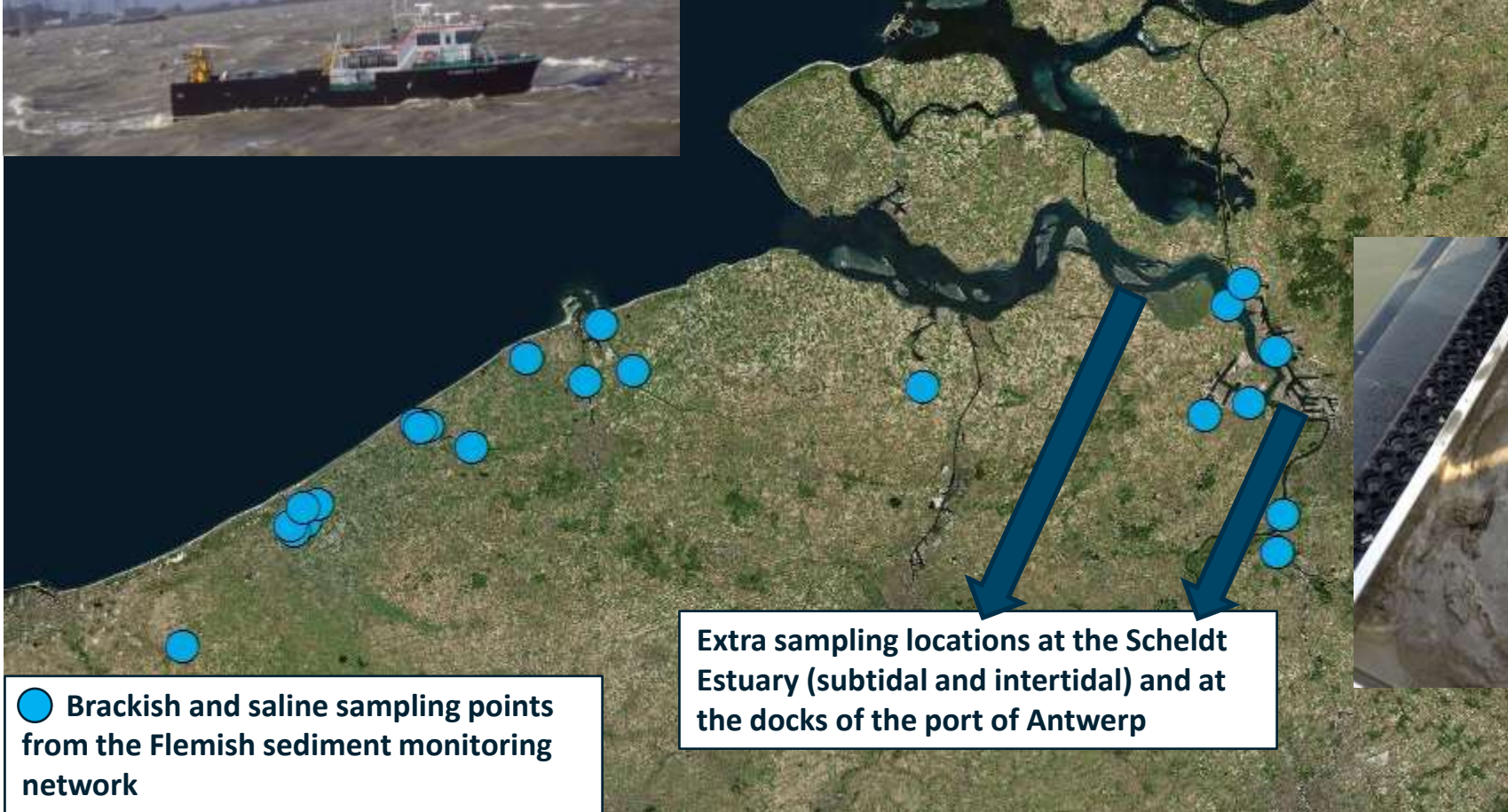


28d sediment contact test with *Hediste diversicolor* (growth and mortality)



48h pore water test with *Brachionus plicatilis* (mortality)

# Sampling locations

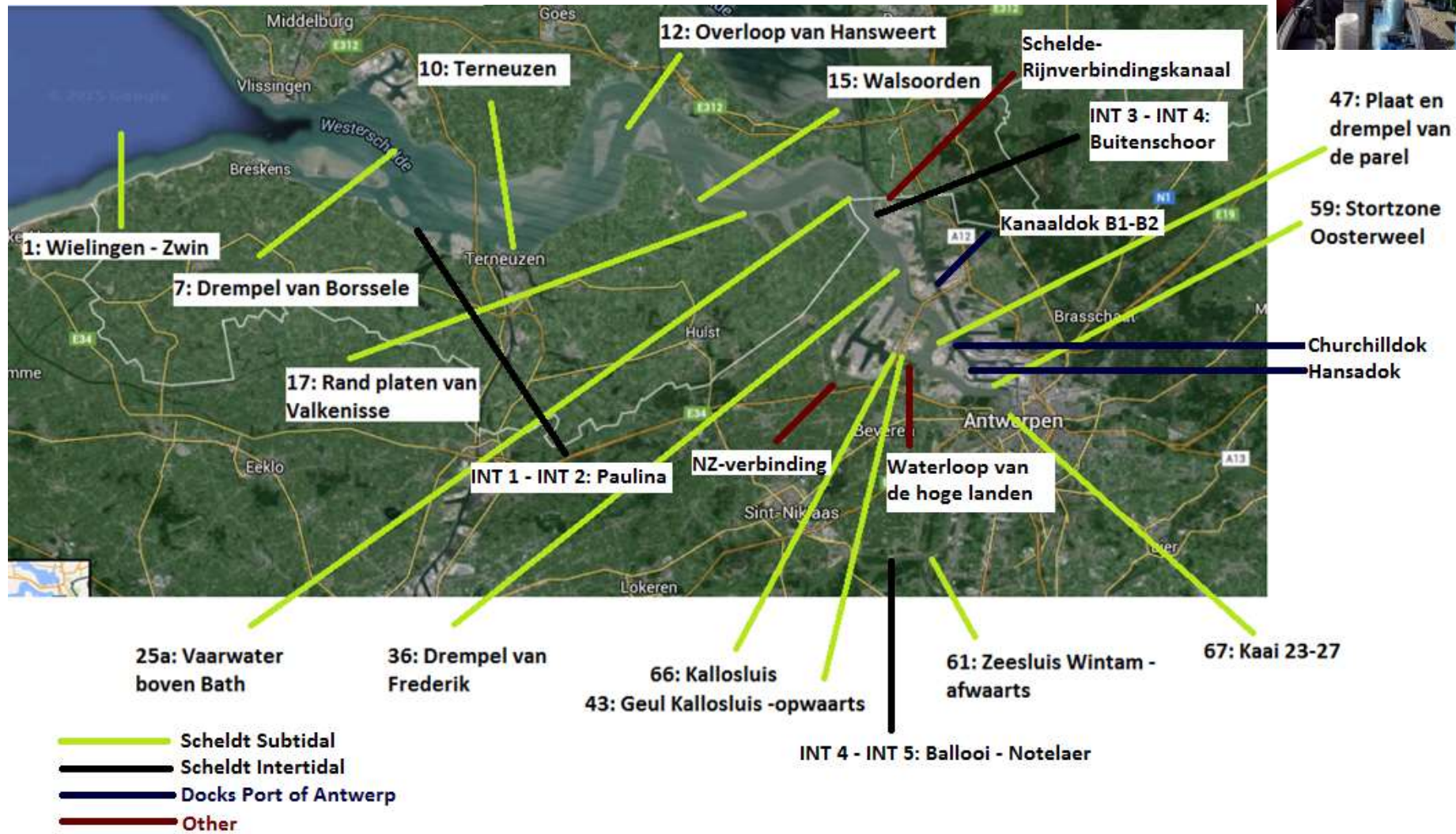


● Brackish and saline sampling points from the Flemish sediment monitoring network

Extra sampling locations at the Scheldt Estuary (subtidal and intertidal) and at the docks of the port of Antwerp



# Sampling locations



# Set-up of Experiments

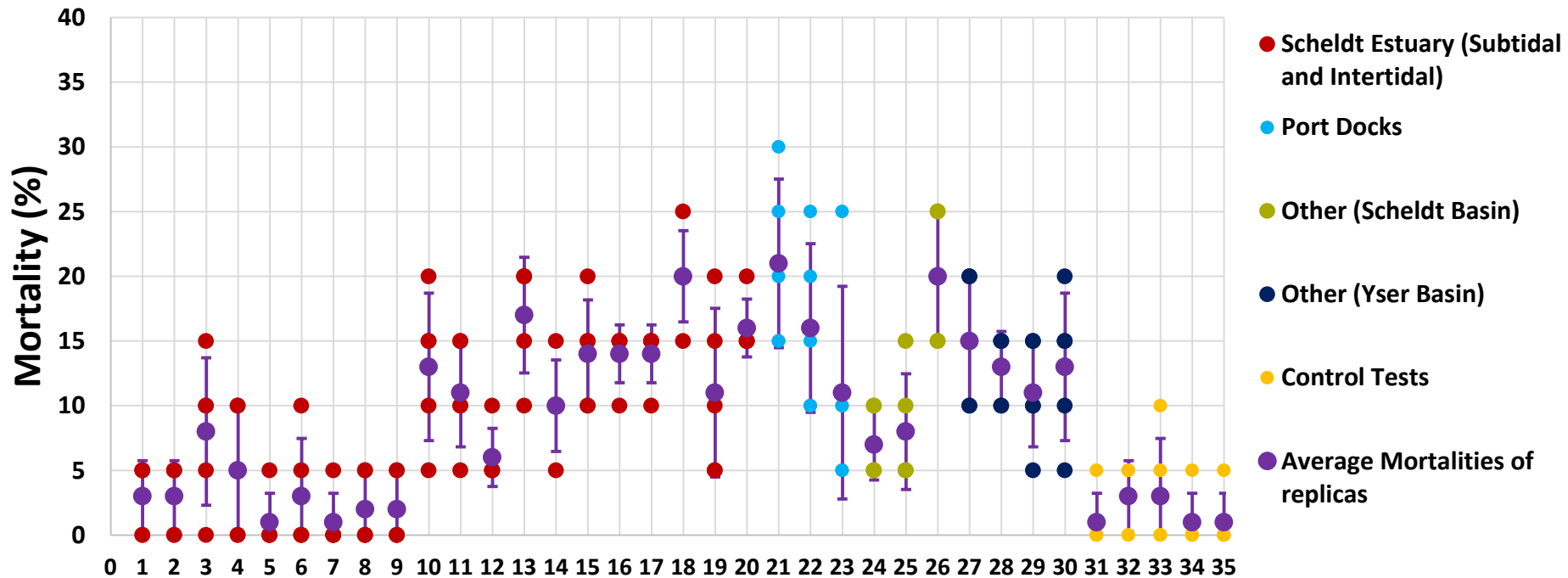
- Sediment contact tests with *H. diversicolor* (28d): 15 replicas - 1 organism per replica
- *C. volutator* (10d): 5 replicas - 20 organisms per replica
- Pore water test with rotifer *B. plicatilis* (ROTOXkit-M) (48h)



# Results - *Corophium volutator*



## Mortality *C. volutator*

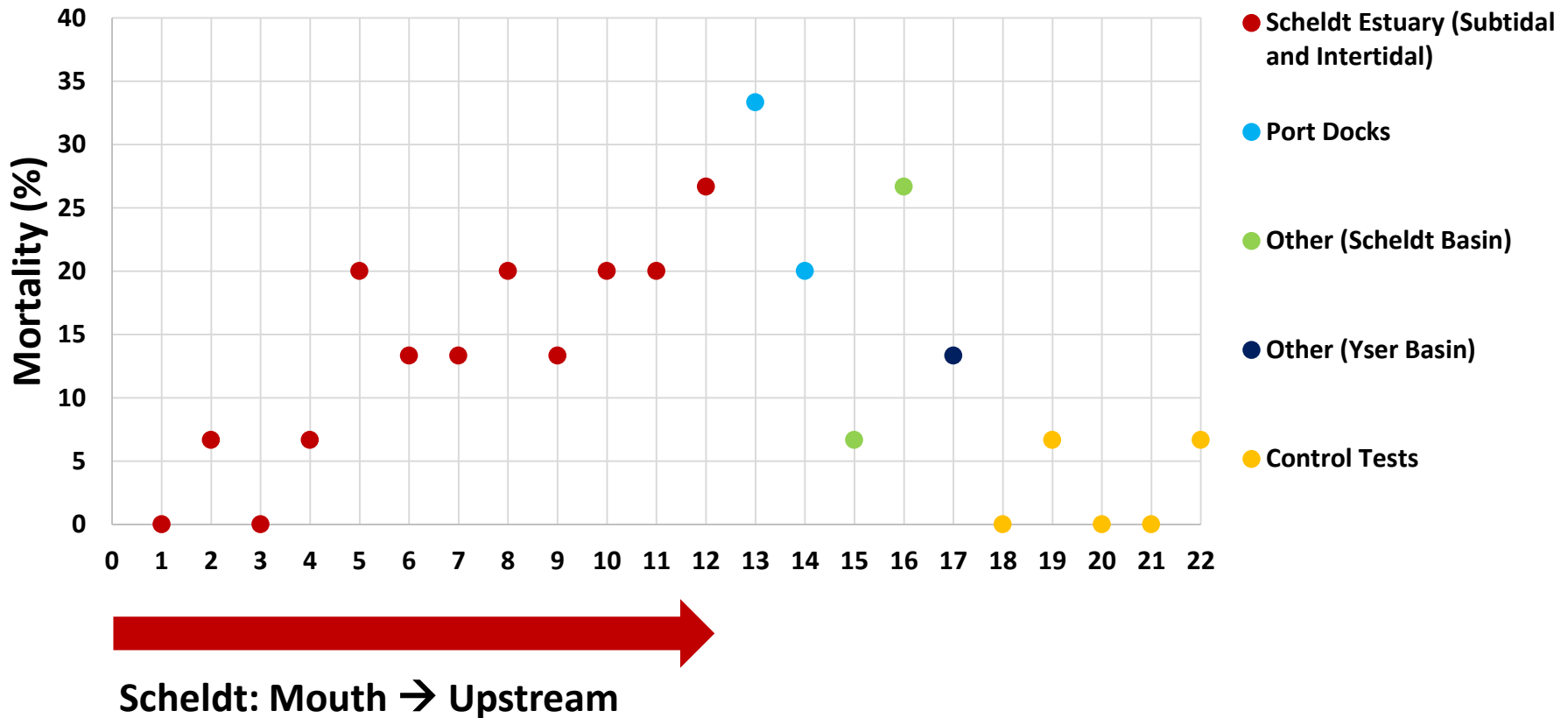


Scheldt: Mouth → Upstream

# Results - *Hediste diversicolor*



## Mortality *H. diversicolor*

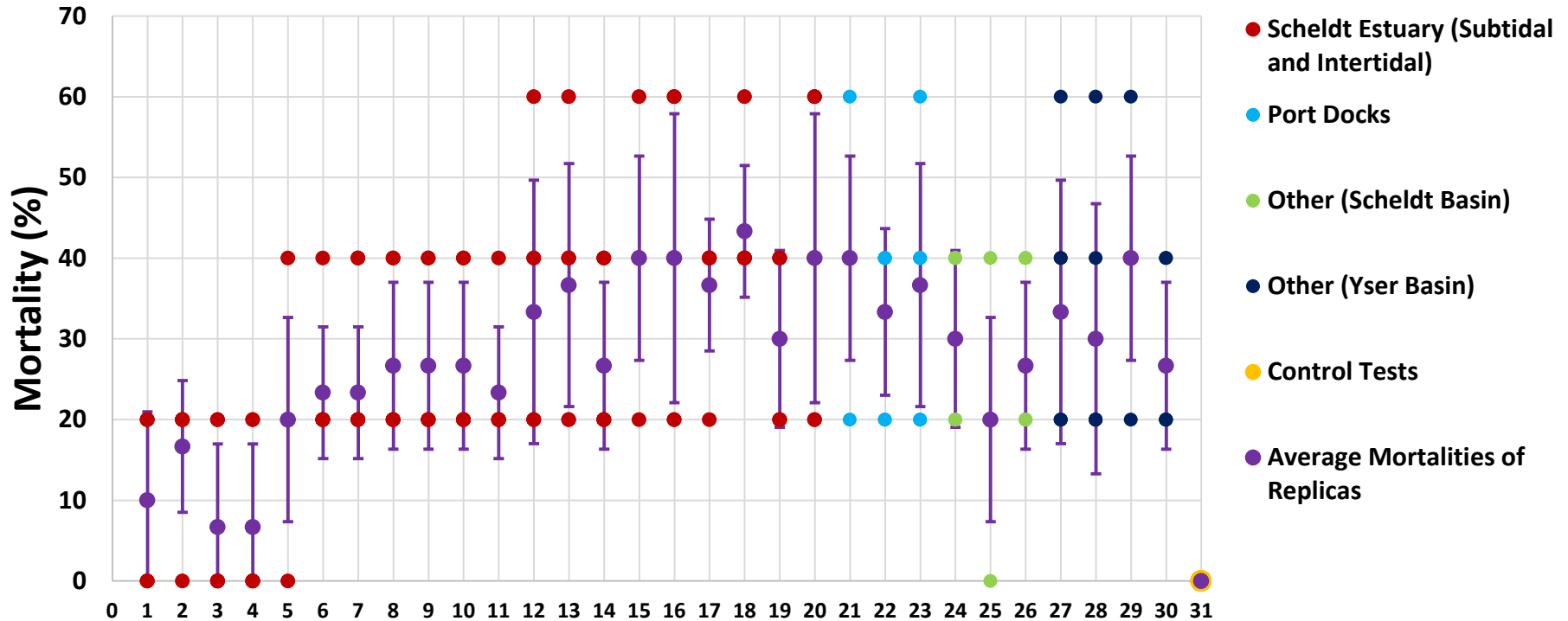




# Results - *Brachionus plicatilis*

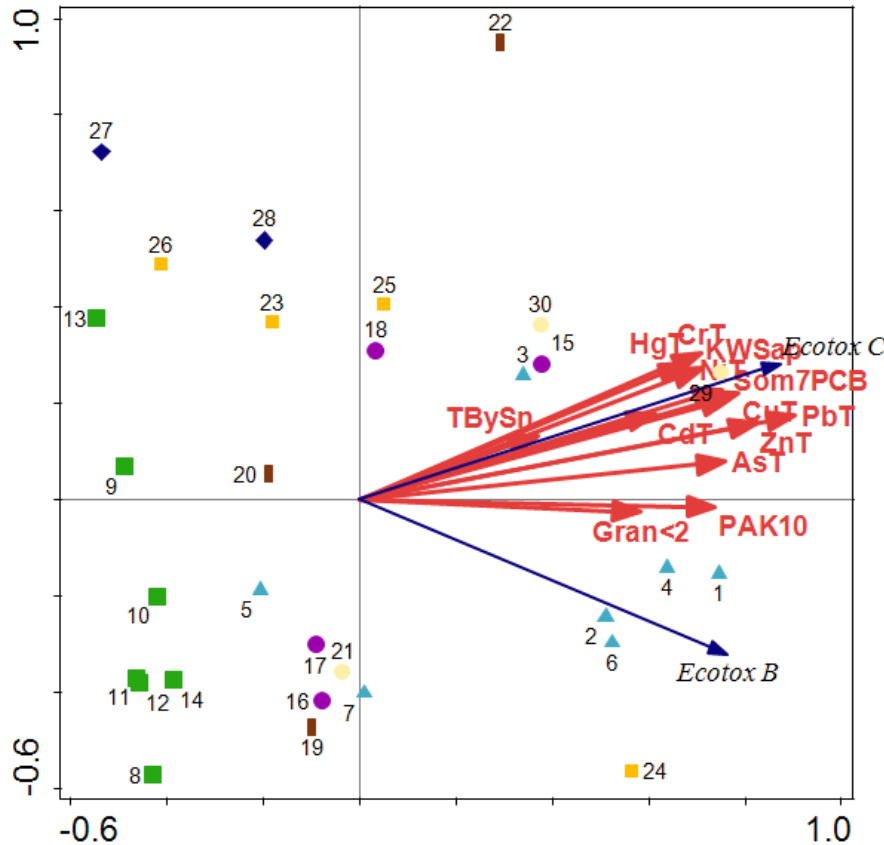


Mortality *B. plicatilis*



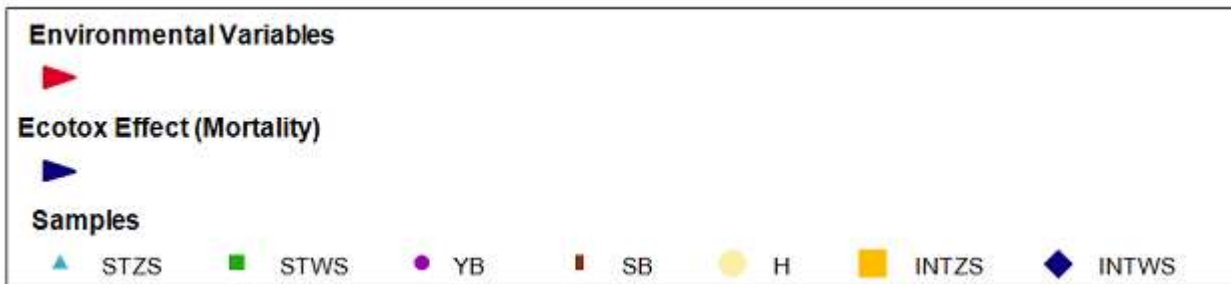
Scheldt: Mouth → Upstream

# Exploratory Multivariate Analysis



	Axis 1	Axis 2	Axis 3	Axis 4
<b>Eigenvalues</b>	0.6740	0.0917	0.1709	0.0634
<b>Explained Variation</b>	67.40	76.57	93.66	100

Simple Effects	Explains %	Conditional Effects	Explains %
Pb t	55.3	Pb t	55.3
Zn t	43.2	Gran < 2	4.9



# Biological quality evaluation



## Non-estuarine brackish/saline waterways

Reference situation of macrobenthos in brackish/saline aquatic systems?

Reference lists (STOWA NL, 2012) of macrofauna in brackish/marine aquatic systems: characteristic, dominant positive and dominant negative species

- Adaptation of macrofauna index to **macrobenthos index**?
- Testing of index/optimization of reference lists using samples of monitoring network (determination to species level)

## Scheldt Estuary

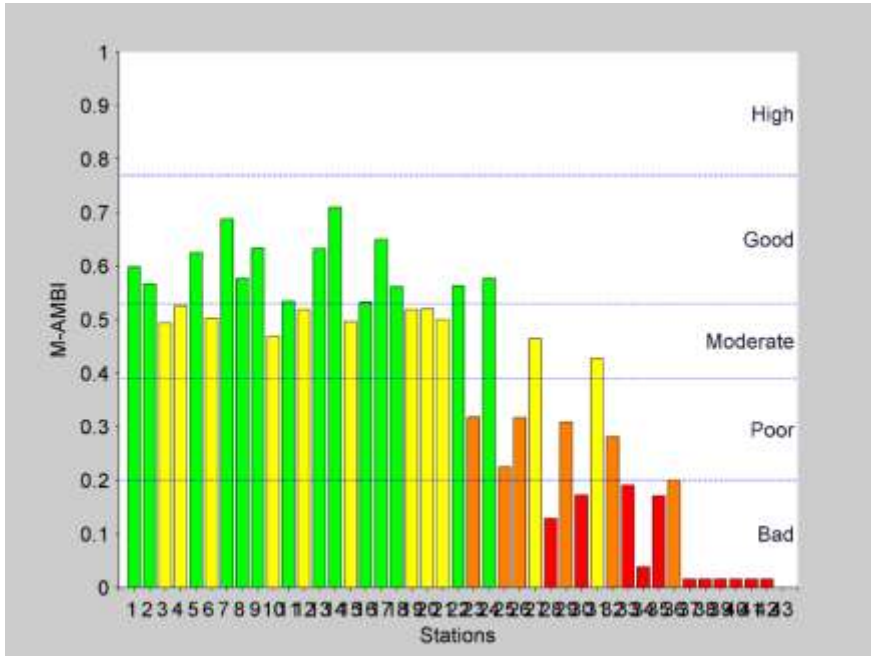
Scheldt Evaluation Method: **Buckland Arithmetic Occurrence Intactness Index**:  
Reference matrices macrobenthos

**M-AMBI Index** (Setting of site specific reference conditions)

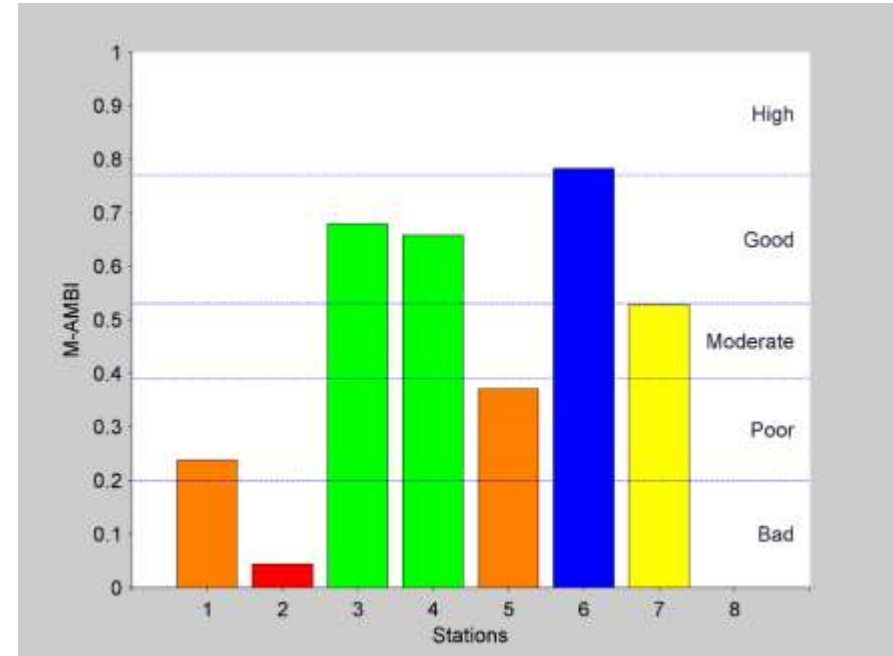
- Requirement of **adapted sampling method/strategy**
- **Application** of biological indices on intertidal sampling locations in september 2017

# Biological quality evaluation

## Application of M-AMBI Index



Scheldt Estuary: Vlissingen (Downstream)  
→ Temse (Upstream) (1990)



Scheldt Estuary (8 sampling locations 2016)  
1: oligohaline low-dynamic, 2: oligohaline high-dynamic, 3: mesohaline low-dynamic, 4: mesohaline high-dynamic, 5: mesohaline subtidal, 6: polyhaline low-dynamic, 7: polyhaline high-dynamic, 8: polyhaline subtidal (0)



# Way Forward

- Optimization of Flemish SQGs for brackish/saline sediments
- Compilation of ecotox and bioaccumulation data (2015-2017): integrating multivariate analysis micropollutants - environmental parameters - ecotox effects
- Possibility of adding microalgae *Phaeodactylum tricornutum* to the test battery
- Further development of macrobenthos index for the evaluation of non-estuarine brackish/saline sediments
- Testing of biological indices in september - november 2017



# Thank You!



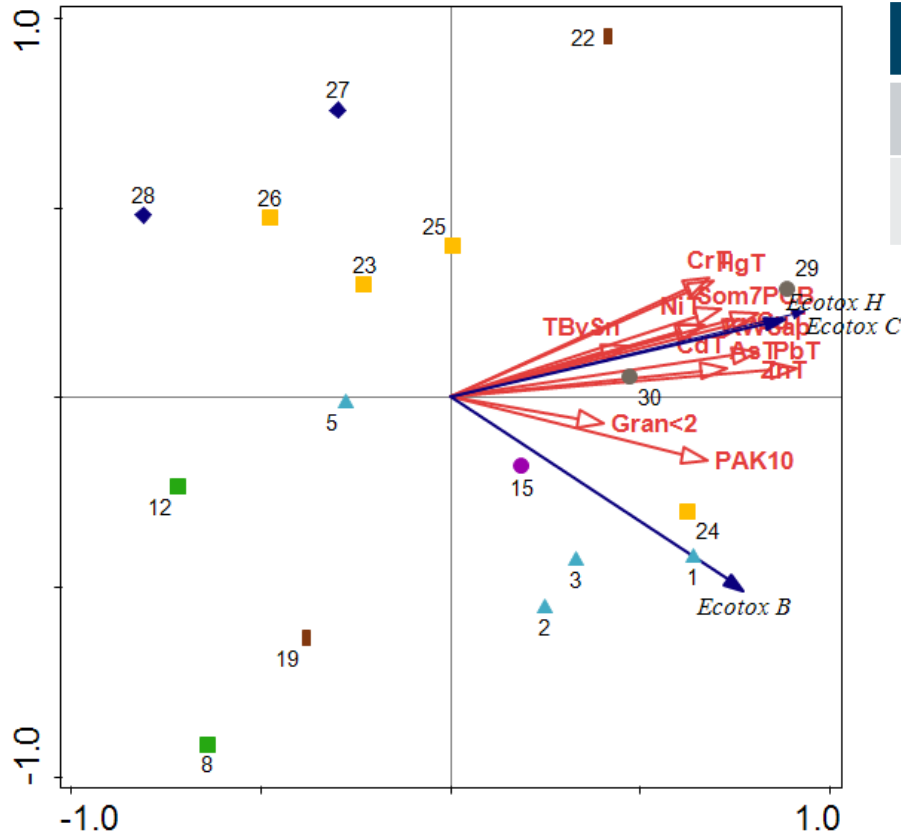
# Results - Exploratory Multivariate Analysis

Ecotoxeffect	Pb	Zn	Cd	PAK 6	M. C.v.	M B.p
<b>Mortality <i>C. volutator</i></b>	Pearson cor.: 0.872** Sig.: 0.005	Pearson cor.: 0.756* Sig.: 0.030				
<b>Mortality <i>B. plicatilis</i></b>	Pearson cor.: 0.906** Sig.: 0.002	Pearson cor.: 0.743* Sig.: 0.035	Pearson cor.: 0.712* Sig.: 0.048	Pearson cor.: 0.715* Sig.: 0.046	Pearson cor.: 0.906** Sig.: 0.002	
<b>Mortality <i>H. diversicolor</i></b>	Pearson cor.: 0.836** Sig.: 0.010	Pearson cor.: 0.816* Sig.: 0.013	Pearson cor.: 0.723* Sig.: 0.043		Pearson cor.: 0.907** Sig.: 0.002	Pearson cor.: 0.905** Sig.: 0.002

**\*: significant correlation at the 0,05 level**

**\*\* : significant correlation at the 0.01 level**

# Results - Exploratory Multivariate Analysis



	Axis 1	Axis 2	Axis 3	Axis 4
<b>Eigenvalues</b>	0.7507	0.1183	0.0281	0.0943
<b>Explained Variation</b>	75.07	86.90	89.71	99.17

## Environmental Variables



## Ecotox Effect (Mortality)



## Samples

- H
- YB
- ◆ INTWS
- INTZS
- SB
- STWS
- ▲ STZS



--> een 72u groei-inhibitietest met het groenwier *Raphidocelis subcapitata* (= *Selenastrum capricornutum*) (testkit microbiotests)

--> een 24u acute mortaliteitstest met de kreeftachtige *Thamnocephalus platyurus* op het poriënwater (testkit microbiotests)

--> acute sedimentcontacttest met de amphipode *Hyalella azteca* (10 dagen).

--> meer recent werd ook begonnen met de sedimentcontacttest Ostracod (6 dagen) (*Heterocypris incongruens*) (testkit microbiotests) (denk dus dat omwille van praktische redenen hier ook werd overgestapt naar een testkit, en dat dan recent de *Hyalella* test niet meer wordt uitgevoerd, en enkel de Ostracod kit wordt gebruikt, dat vraag ik nog eens na bij de VMM).