eman eta zabal zazu

Euskal Herriko Unibertsitatea
Universidad País Vasco

THE USE OF THE *SEDIMENT QUALITY TRIAD* FOR QUALITY ASSESSMENT OF FRESHWATER SEDIMENTS IN NORTHERN SPAIN

Zuriñe Maestre, Pilar Rodriguez and Maite Martinez-Madrid

Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

OBJECTIVES

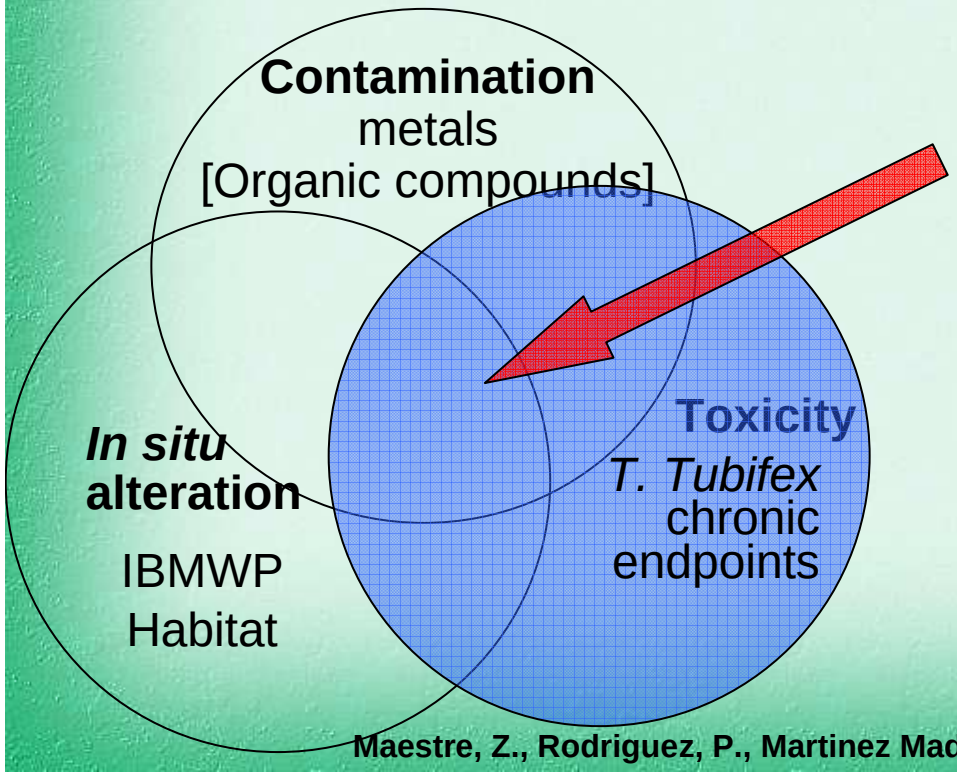
- To provide a screening-level ecological risk assessment of freshwater sediments using 3 Lines of Evidence: Sediment Chemistry, In-situ Alteration and Sediment Toxicity

- To evaluate the contribution of sediment toxicity data and Sediment Quality Triad (SQT) to the Ecological Status assessment performed by Spanish Water Authorities

Study Region

Water Quality Surveillance Networks

- Environment and Territorial Planning Dept of the Basque Government
- Housing and Territorial Planning Dept of the Navarra Government
- Ebro Hydrographical Confederation
- Northern Hydrographical Confederation



Integrative assessment

Water Authorities provided data on sediment chemical concentration and/or benthic community data for 60 sites (2004-06)

Sediment Chronic Toxicity Test

***Tubifex tubifex* (Annelida, Clitellata) 28-day sediment chronic bioassay**

(Reynoldson et al 1991, Martinez Madrid et al 1999, ASTM 2005)

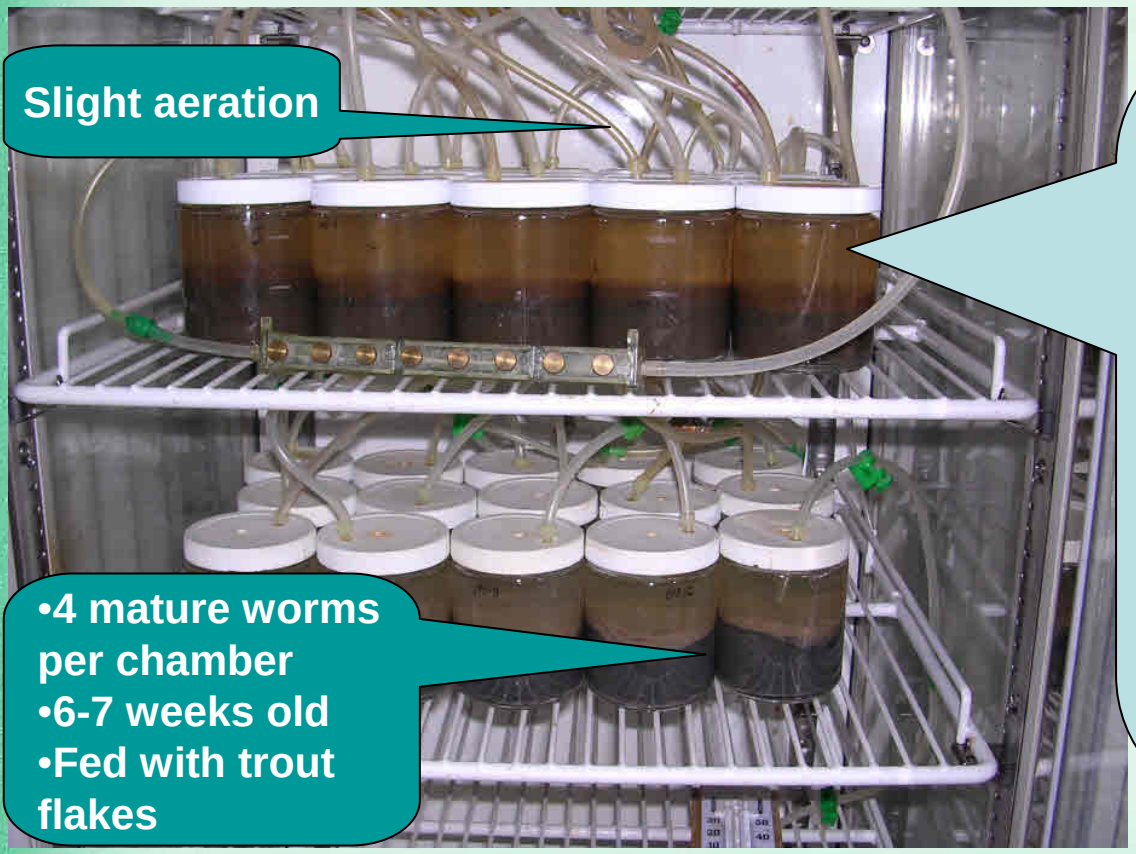
Endpoints:

- *%Survival*
- *CCAD* (N. of cocoons/adult)
- *%Hatch* (N. empty cocoons/N. total cocoons)
- *YGAD* (N. young/adult)
- *TGR* (Total Growth Rate, mg dw d^{-1}, somatic and reproductive biomass)

Sediment Chronic Toxicity Test

Tubifex tubifex **(Annelida, Clitellata) 28-day sediment chronic bioassay**

(Reynoldson et al 1991, Martinez Madrid et al 1999, ASTM 2005)



EXPOSURE CONDITIONS

- **22.5 ± 0.5º C**
- **in the dark**
- **Test chamber: 250 ml**
- **Sediment volume:**

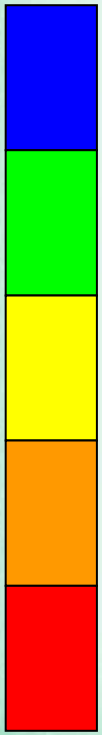
100 ml, sieved through 500 µm mesh

- **Overlying dechlorinated water: 100 ml. No water renewal**

LOE 1: *In situ* Alteration- Biota

$$\text{Ecological Quality Ratio (EQR) for IBMWP} = \frac{\text{Observed value}}{\text{Reference Condition Value in each ecoregion}}$$

EQR close to 1



		Ordinal ranking for TRIAD
Very Good status	No or very minor deviation from the reference condition (RC)	-
Good status	Slight deviation from the RC	
Moderate status	Moderate deviation from the RC	±
Poor status	High deviation from the RC	+
Bad status	Very High deviation from the RC	

EQR close to 0

Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

LOE 1: *In situ* Alteration- Habitat

METRICS

- QBR: a riparian wood index (Munné et al. 1997) that includes both river-bed and riparian wood characteristics analyses.
- Hydro-morphological alterations (H-A): assess river continuity, hydrological regime, hydrodynamics, and so on.

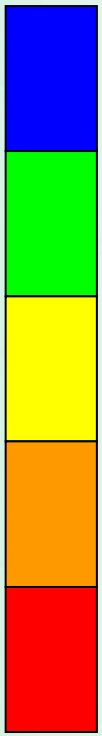
TRIAD ordinal ranking	-	±	+
Habitat Alteration (QBR & H-A)	No or slight alteration	Moderate alteration	High or extreme alteration

In situations where habitat alterations are detected, reliance must be placed on the sediment toxicity (Chapman 2007)

LOE 2: Sediment Toxicity

Procedure to establish the reference condition for the *T. tubifex* sediment bioassay endpoints:

IBMWP - EQR



Very Good status

Good status

Moderate status

Poor status

Bad status

First step: Select "Possible" reference sites

Second step: Apply criteria for excluding altered reference sites (Reynoldson et al. 2002) :

- sites with less than 50% survival
- sites with 2 or more sublethal endpoints below the 5th percentile

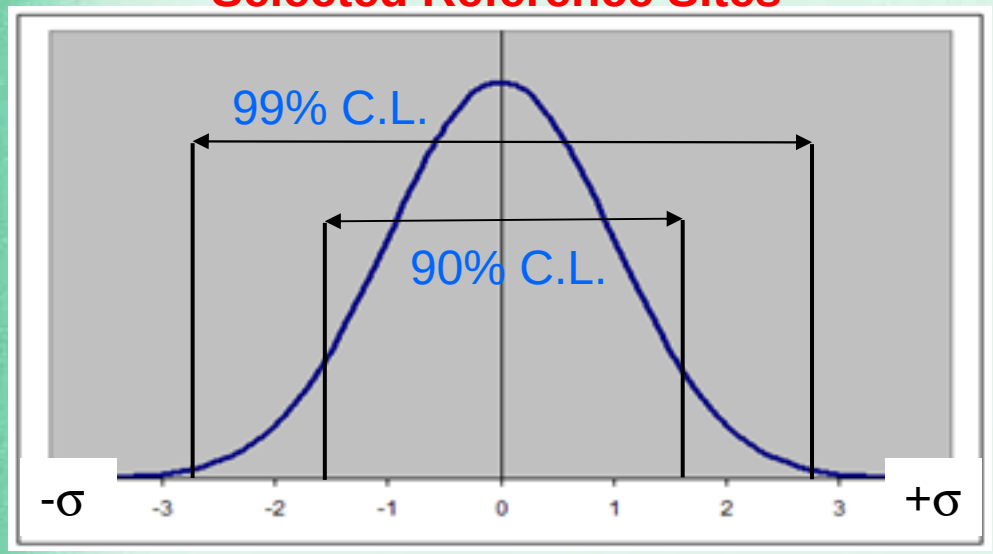
Third step: Establish 3 categories of toxicity for each endpoint to classify test-sediments

Selected Reference Sites

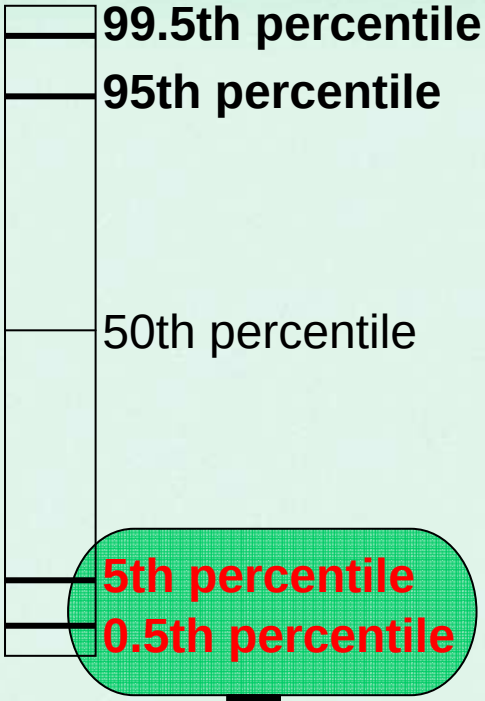
Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

LOE 2: Sediment Toxicity

Selected Reference Sites



Reference-sites endpoint values distribution



CATEGORIES OF RESPONSE TO SEDIMENTS

	%Survival	CCAD	%Hatch	YGAD	TGR	TRIAD
Non-Toxic	>76.0	>6.5	>11.2	>2.8	>0.83	-
Potentially Toxic	75.0-61.3	6.4-5.7	11.1-6.1	2.7-1.5	0.82-0.39	±
Toxic	<61.2	<5.6	6.0	1.4	0.38	+

Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

LOE 3: Bulk-sediment metal concentration

No SQG for the study region

Test Effect-based SQG developed for other regions:

- Consensus-based PEC (USEPA, 2000; MacDonald et al. 2000),
- PEL (NOAA, 2006; Canadian Environmental Guidelines, 2003),
- RV-Y (Flanders, ANZECC, 1997-2008),

(following methodology described in Vidal & Bay 2005)

Consensus-based PEC was the SQG that best predicts samples as Non-toxic or Toxic

Criteria (based in Chapman & Anderson 2005)	Assessment	TRIAD ordinal ranking
All Metal concentrations < TEC	Adverse effects unlikely	-
≥1 metal concentration > TEC	Adverse effects may / may not occur	±
≥1 metal concentration > PEC	Adverse effects likely to occur	+

RESULTS

SEDIMENT QUALITY TRIAD (SQT) decision matrix

Bulk Sediment Metal Concentration	Adverse effects unlikely	Adverse effects may or may not occur	Adverse effects likely
Sediment Toxicity (Survival, Growth & Reproduction)	Negligible response	Potential response	Significant response
In -situ Alteration: Benthos (IBMWP) Habitat (QBR,H-A)	Equivalent to the reference condition	Possibly different from the reference condition	Different or very different from the reference condition
TRIAD ordinal ranking	-	±	+

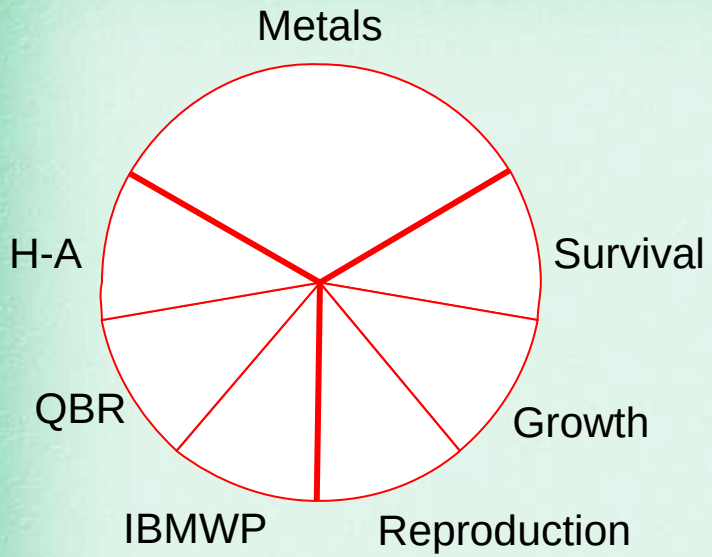
Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

Decision matrix for WOE categorization: Examination of 5 scenarios

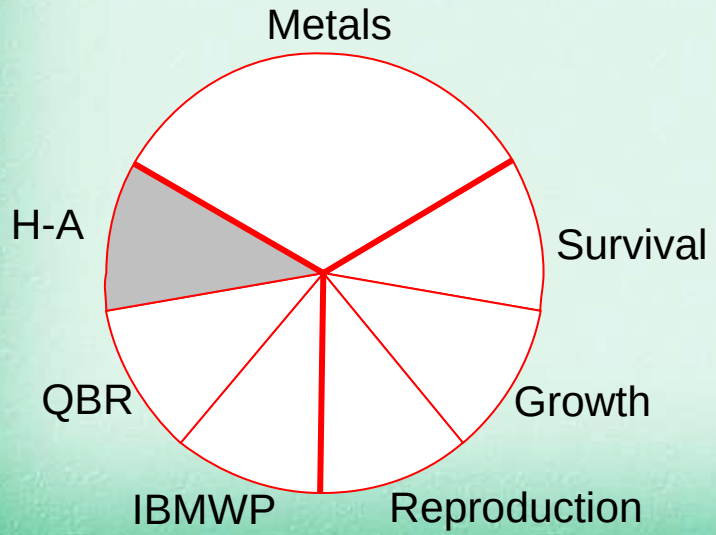
Sediment	Metal Conc.	Toxicity				*In situ* Alteration		
		Surv.	Growth	Reprod.		IBMWP	QBR	H-A
ZAY 018	-	-	-	-	A	-	-	-
OKMA 040	-	-	-	-		-	-	±
RCVA 178	±	-	-	-	B	-	-	-
OI 102	+	-	-	-		-	+	-
URS 34	±	-	+	+	C	-	-	
SP 18	+	-	+	±		-	+	+
A 202	±	-	-	-	D	±	±	-
BA 558	+	-	-	-		+	±	+
AS 160	+	±	-	±	E	±	+	+
SP 8	+	+	+	±		±	±	±

Scenario A: □: (-) no significant adverse effect ▭: (±) potential adverse effect ■: (+) significant adverse effect

ZAY 018



OKMA 040



Water Authorities (EWF):
High or Good Ecological Status

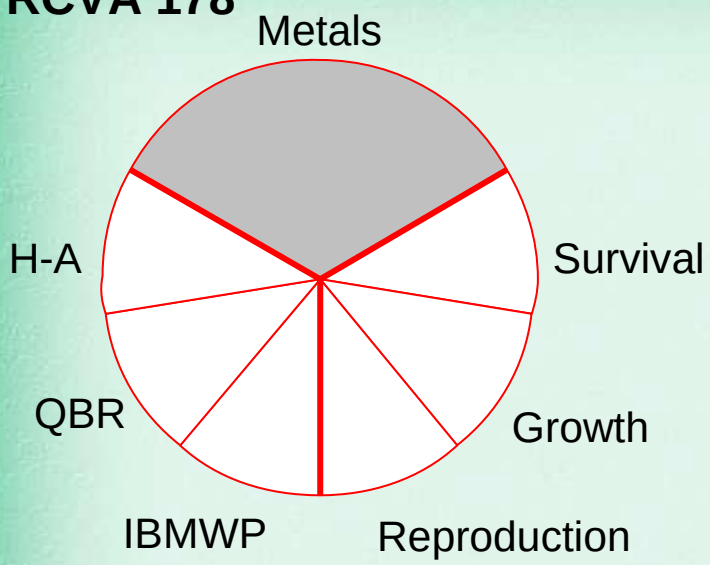
SQT: Sediment unpolluted. No evidence of Adverse biological effects

SQT supports the Ecological Status category. No risk present. No further action required

Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

Scenario B: □: (-) no significant adverse effect ▒: (±) potential adverse effect ■: (+) significant adverse effect

RCVA 178



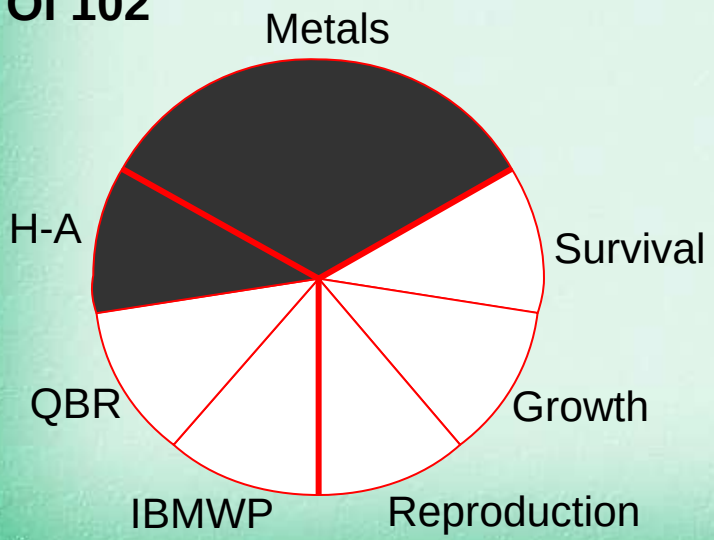
Water Authorities (EWF):

RCVA 178 High Ecological Status

OI 102 Poor Ecological Status

SQT:Contaminants present, but not available in current situation. No adverse biological effects

OI 102

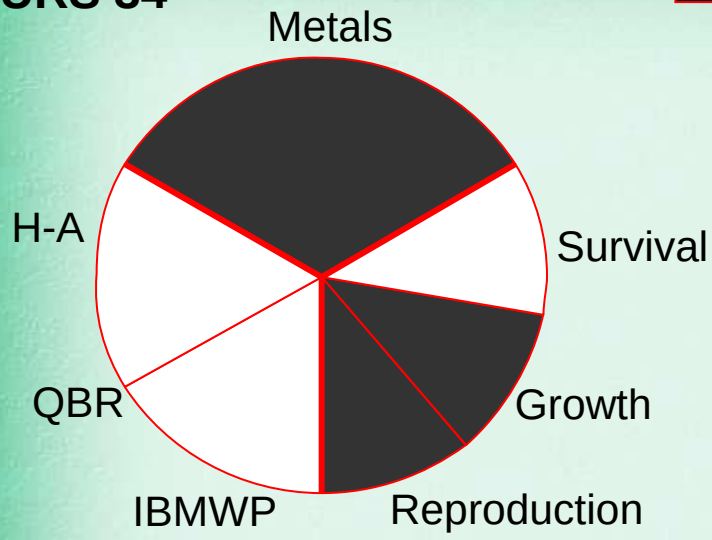


SQT evidences that currently contaminants don't represent an ecological risk

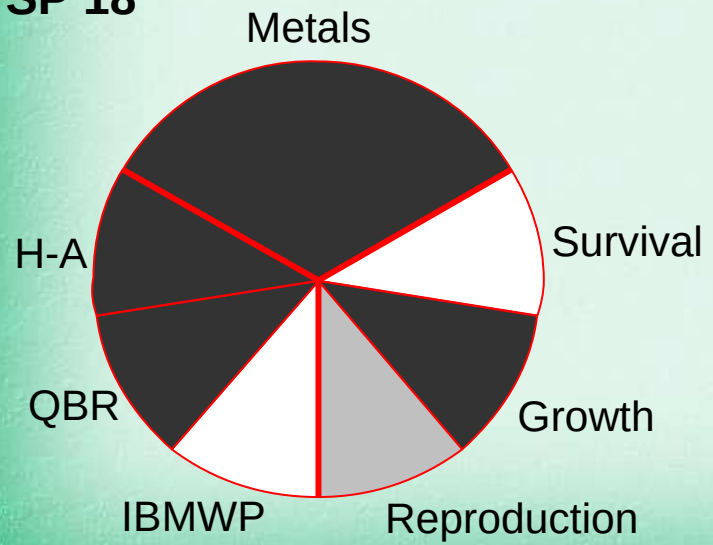
Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

Scenario C: □: (-) no significant adverse effect ▭: (±) potential adverse effect ■: (+) significant adverse effect

URS 34



SP 18



Water Authorities (EWF):

URS34 High Ecological Status

SP18 Bad Ecological Status

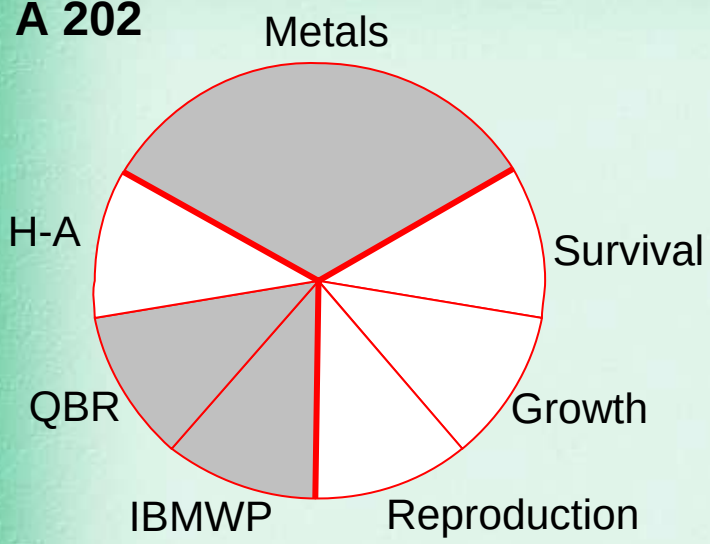
SQT:Contaminants present. Sediment Toxic, but there is no evidence of field community alteration.

SQT provides evidences of Potential Adverse effects. Further analyses required (e.g. *in situ* tests)

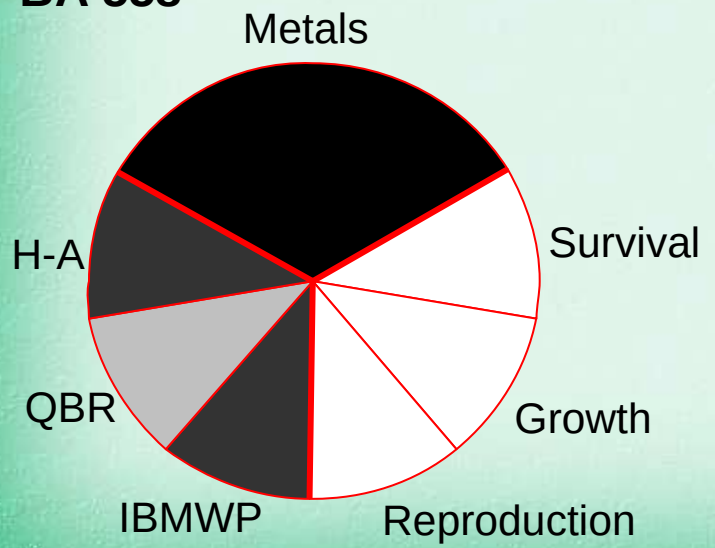
Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

Scenario D: □: (-) no significant adverse effect ▭: (±) potential adverse effect ■: (+) significant adverse effect

A 202



BA 558



Water Authorities (EWF):

A202: Poor Ecological Status

BA558: Bad Ecological Status

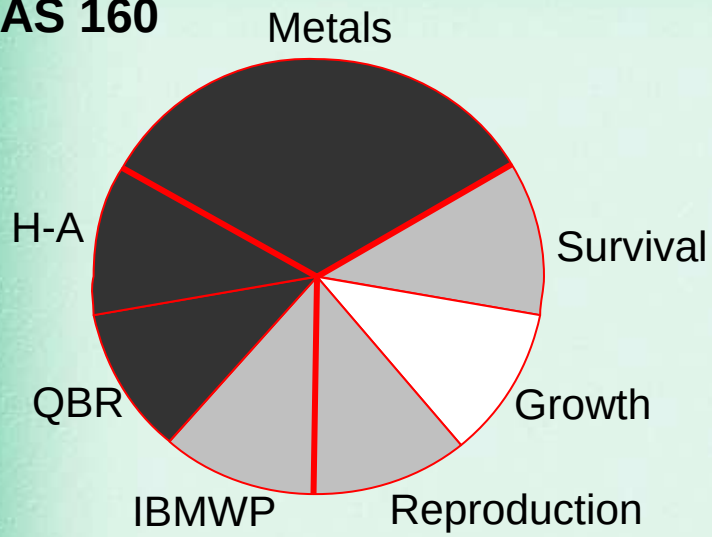
SQT:Contaminants present Sediment Non-Toxic.There is evidence of field community and habitat alteration

SQT provides evidences of adverse effects occurring by unknown causes. Further analyses required (e.g. other test-species, in-situ tests)

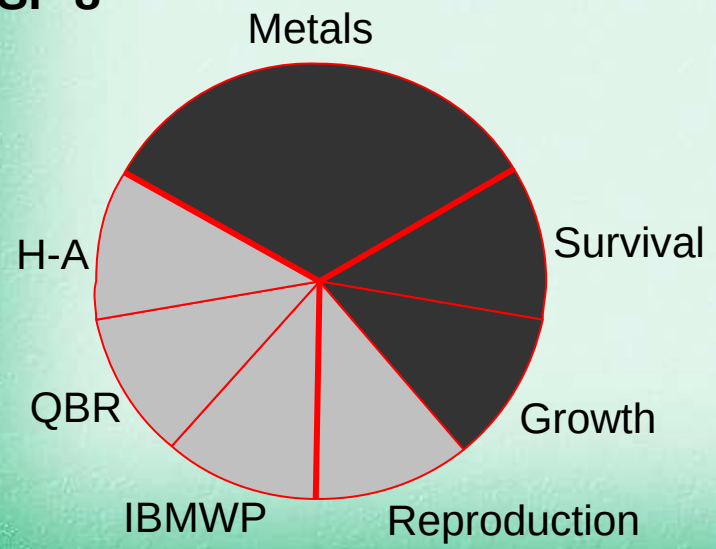
Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

Scenario E: □: (-) no significant adverse effect ▭: (±) potential adverse effect ■: (+) significant adverse effect

AS 160



SP 8



Water Authorities (EWF):

AS 160: Bad Ecological Status

SP 8: Poor Ecological Status

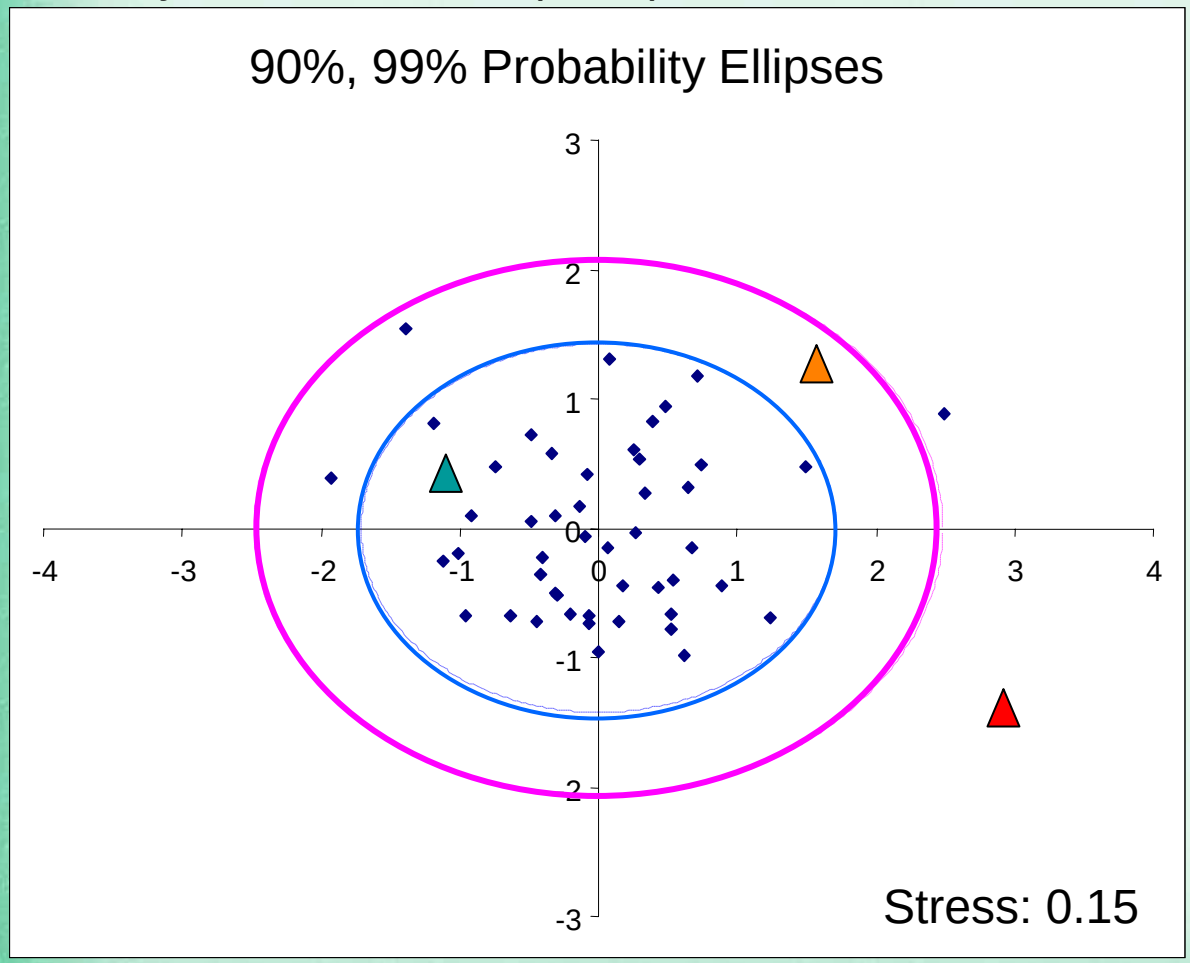
SQT: Sediments highly polluted and toxic. Evidence of field community alteration.

SQT provides evidences of adverse effects and an unacceptable risk from sediment contamination. It supports the Ecological Status

Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

REFERENCE CONDITION APPROACH
(Reynoldson et al. 2002)

Toxicity data ordination (MDS) of reference sediments



Toxicity categories:

- ***Non-Toxic***: inside 90% probability ellipse
- ***Possibly Toxic***: between 90% and 99% probability ellipses
- ***Toxic***: outside 99% probability ellipse

Maestre, Z., Rodriguez, P., Martinez Madrid, M. 5th International SedNet Conference, Oslo, Norway

CONCLUSIONS

➢ Problems for the integration of *ALL* databases:

- Water Authorities measured different **Organic Compounds** in all sites. In consequence, they could not be included in the decision matrix
- Lack of standardization of the **sediment fraction** used for chemical analyses done by different Water Authorities
- Ecoregions shared by different Water Authorities had different values for the **ecological reference condition**, which was incongruent.

➢The SQT provides an Ecological Risk Assessment that supports Ecological Status for sites in the extreme range of the risk assessment (+) and (-) (45% sites). In other intermediate situations, SQT has proved the utility of the Toxicity Line of Evidence as indicative of potential environmental risk (28% sites). In other sites (27%), further research is required because of insufficient information.