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BEHAVIOR AND ECOLOGICAL RISK OF PRIORITY AND/OR EMERGING ORGANIC COMPOUNDS IN AQUATIC ECOSYSTEMS

**Microinquinanti & contaminanti emergenti,
11 e 12 Giugno 2018, Milano**

Which items?

a. ***Monitoring Strategy: WFD Directive 2000/60 requires evaluation of aquatic ecosystems according to operative, surveillance or investigation monitoring.***
According to monitoring type, environmental compartment of concern, temporal and spatial variability and trends, different trophic levels, physiological status and exposure pathway of organisms must be considered

b. ***Behavior : interaction between abiotic and biotic compartments:***
- ***Bioavailability***
- ***Toxic effects measured at different levels of biological organization (from molecular to community level)***

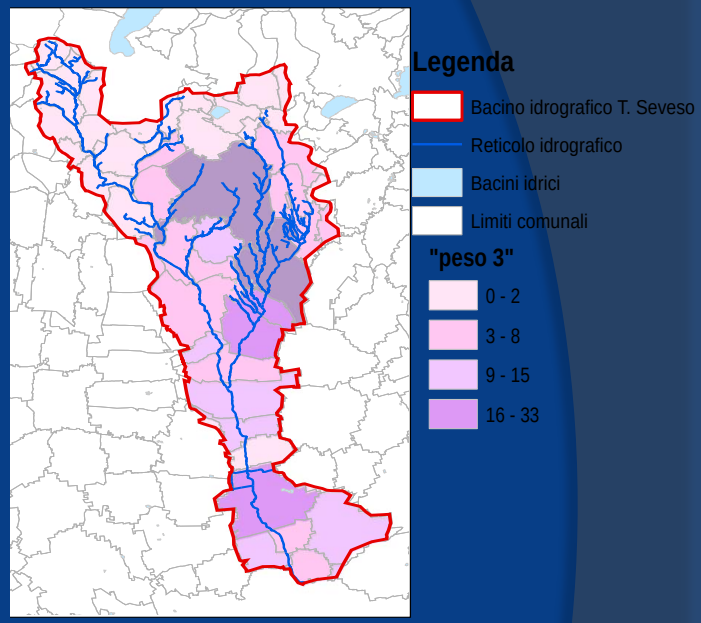
c. ***Last but not least - Risk : biodegradation and metabolic activation, different use of waters, relation between aquatic and terrestrial ecosystems***

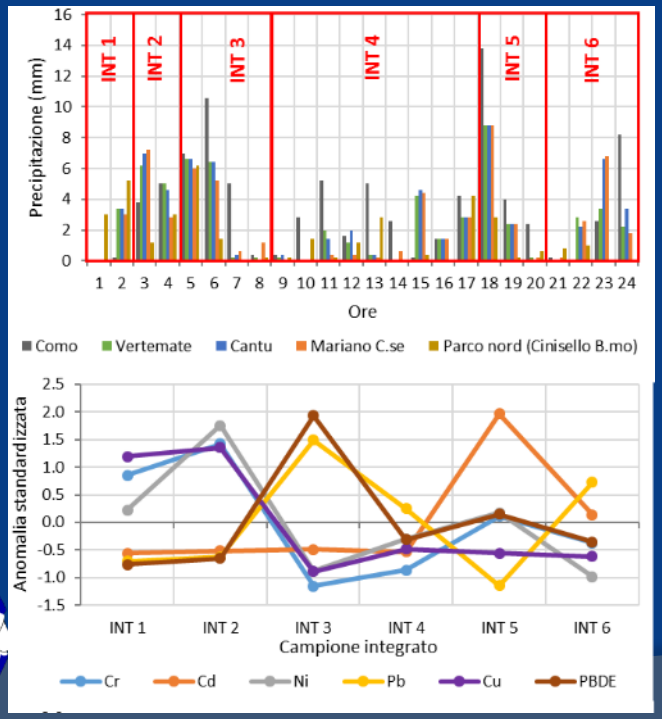
Monitoring Strategy
Directive 2000/60 and Italian Law 2015/172

Which contaminants?

Selection follows actual priority and hazardous substance list, but also must be integrated with analysis of anthropogenic pressures.

***Seveso River basin** with potential **PBDE emissions** sources*





Rain event on 11-12 May 2016 at different stations of Seveso River and concentrations of **pollutants in total suspended solids** (Cr, Cd, Ni, Pb, Cu, PBDE)

Da: Monitoraggio qualitativo delle acque del Torrente Seveso Rapporto IRSA, 2016

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Abiotic compartments: water, sediments and suspended solids

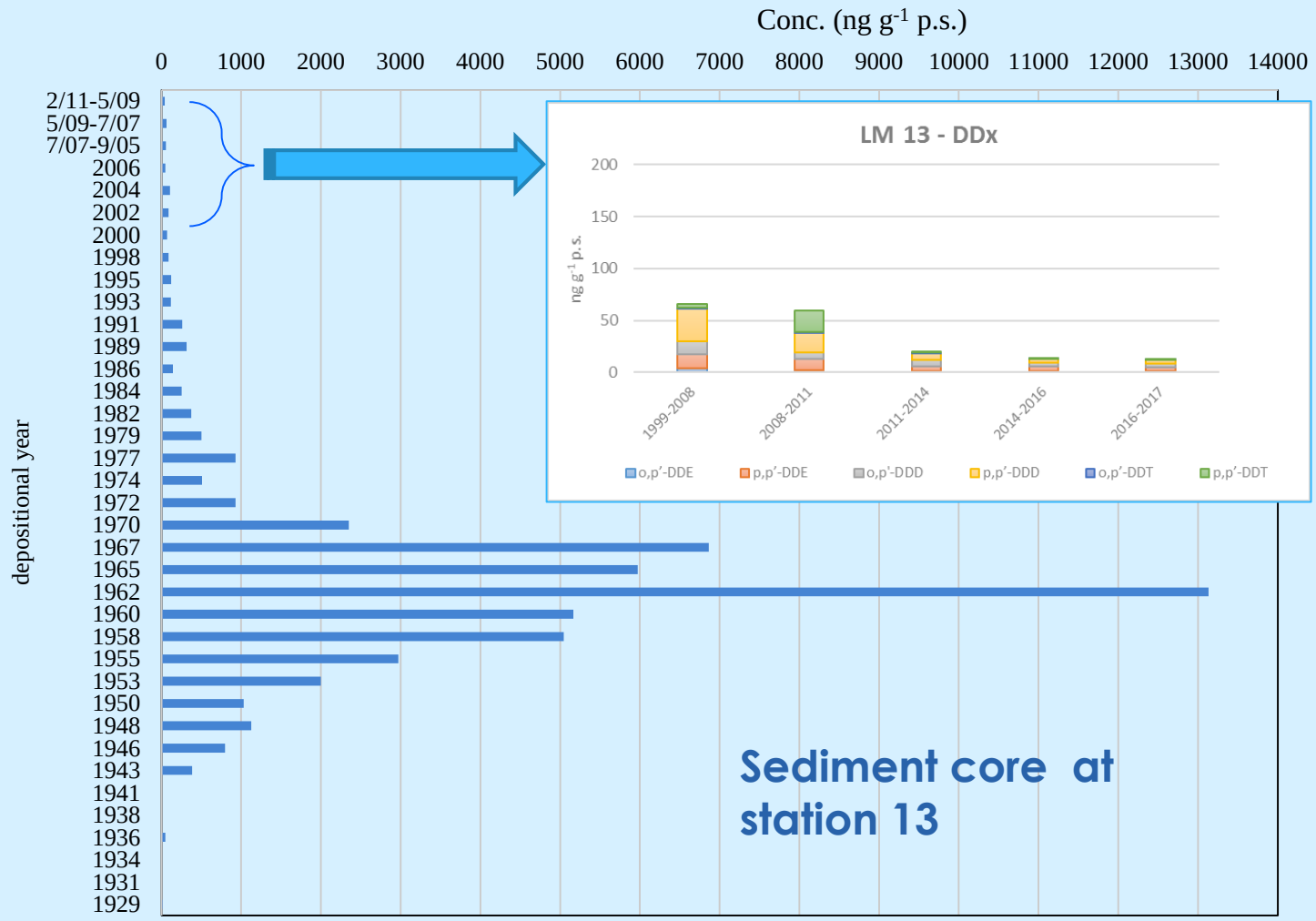
River sediment grab sampling

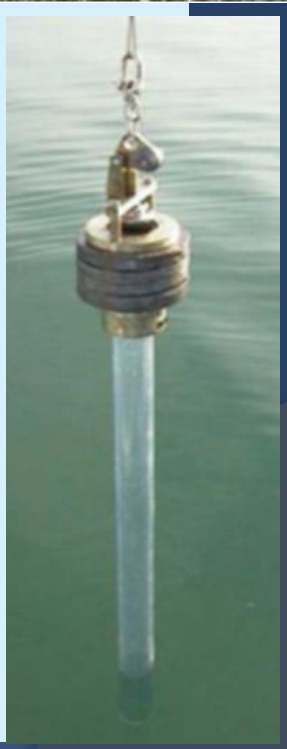
24 hour sampling for waters

According to the physical-chemical characteristics of pollutants, the matrix to be considered must be different. Sediments may be a sink or a source of contamination:

for example PCB, PBDE, DDT, ect... are accumulated in sediments and suspended particulate; PCP (Personal Care Products as limonene) or PFC (PerFluorinated Compounds) are present mainly in water because of their solubility.

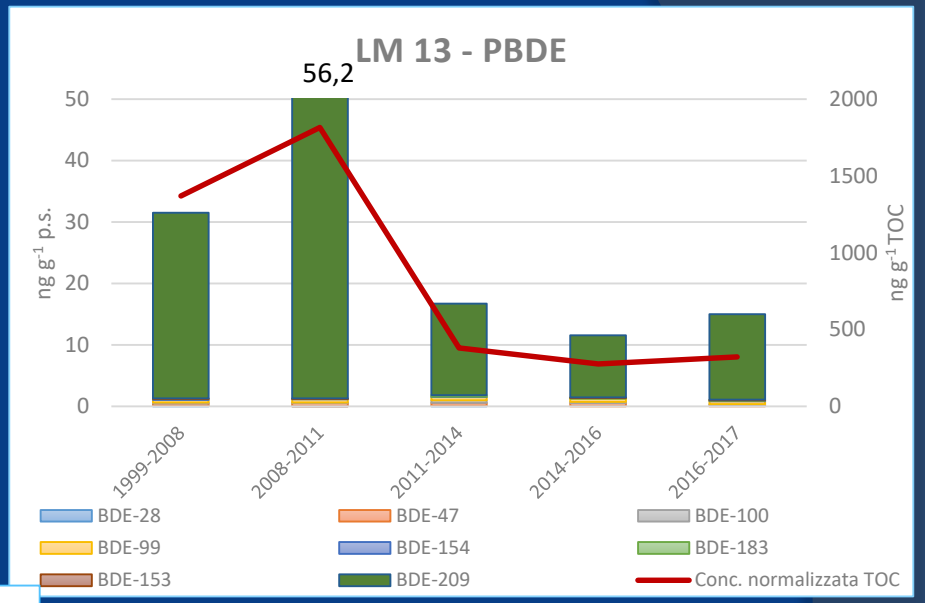
DDx trends in a core sediment collected in the Pallanza Basin, Lake Maggiore

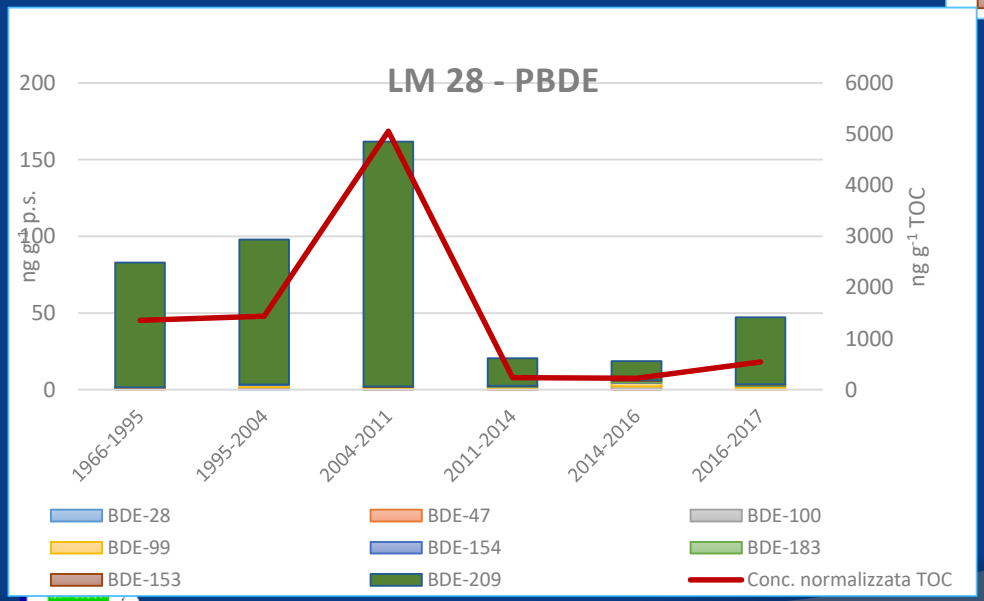




Temporal trends: sediment cores in Lake Maggiore

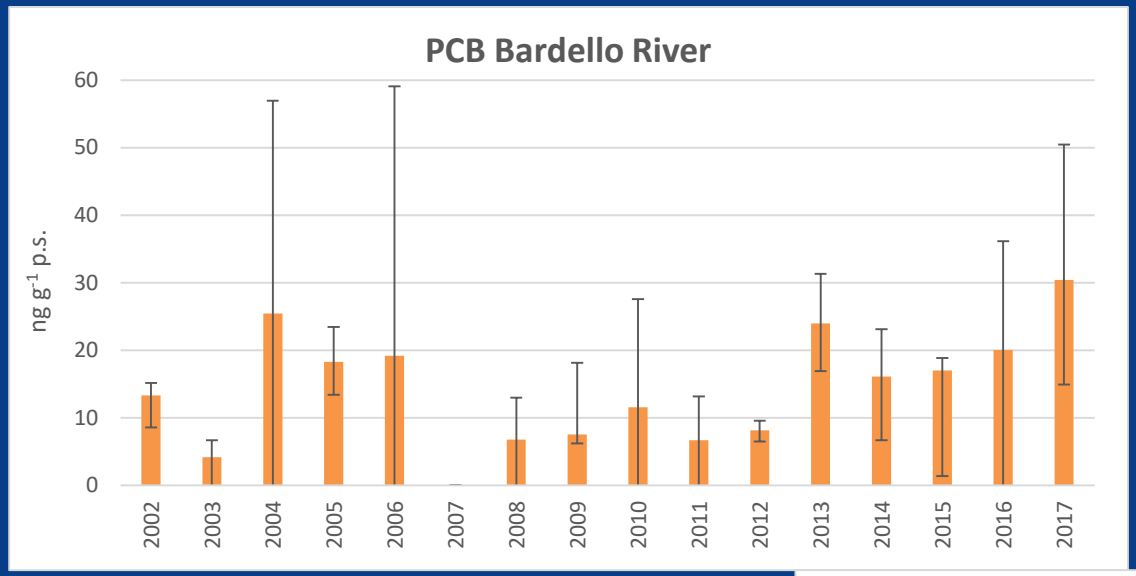
Brominated flame retandant used for plastic housing, syntetic textile and electronic devices. The use **of tri to epta BDE** (ng/g) was **BANNED**

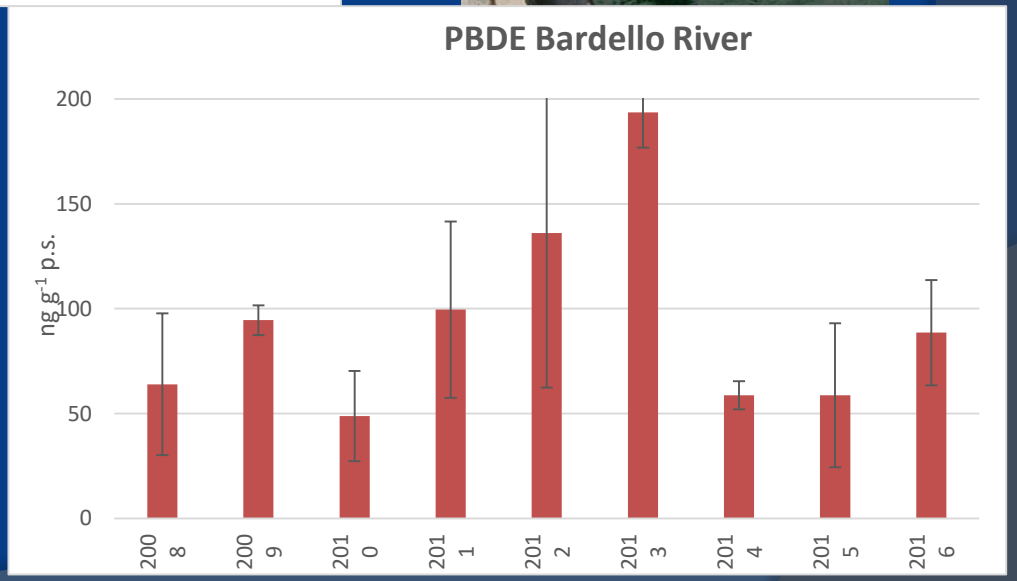




Deca-BDE (BDE-209) showed maximum concentrations in 2011, the use of this compound is restricted.
PBDE are endocrine disruptors (interfence with tyroxin ormones) and neuro-toxic.

Sediment trends in rivers





Biotic compartment: site-specific data

Benthic invertebrates: collected with hand nets in the Toce River. Specimens were separated according to taxonomic group and/or functional feeding group

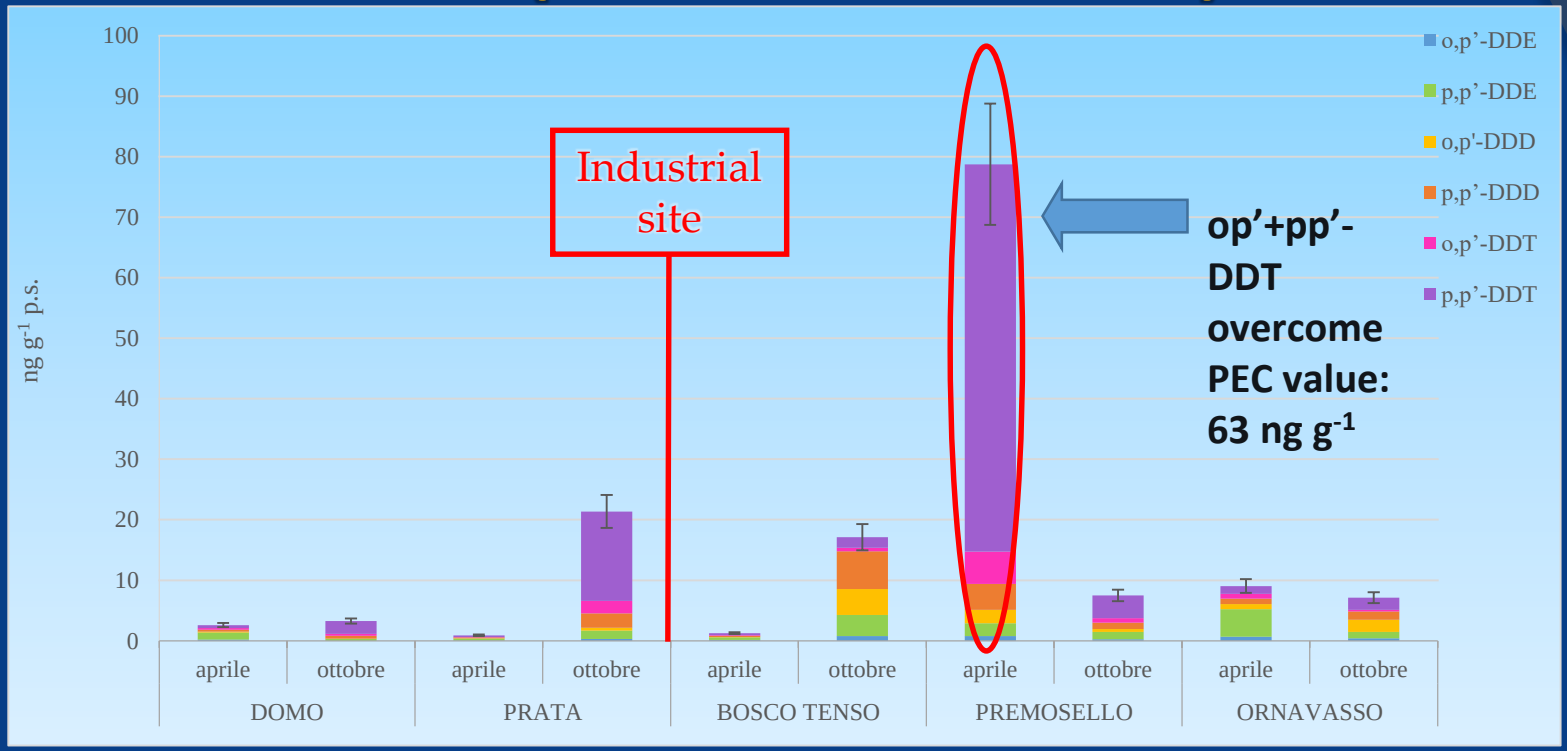
Coregonus lavaretus

Alosa fallax lacustris

Fish: collected in the Pallanza Bay using gill nets:

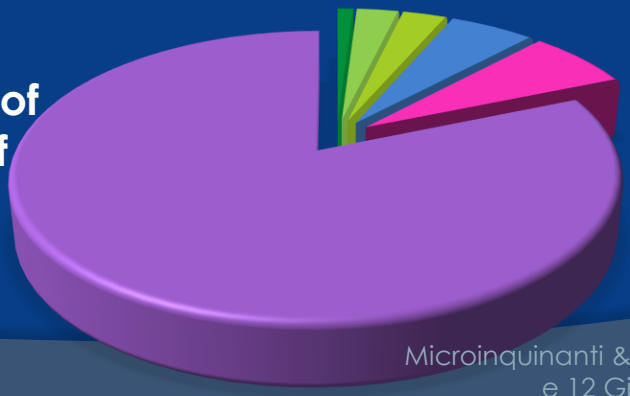
- *Rutilus rutilus* (roach): littoral, bentophagic
- *Coregonus lavaretus* (common whitefish) : pelagic, planktophagic
- *Alosa fallax lacustris* (landlocked shad): pelagic, planktophagic

Behavior: sediment contamination in Toce (DDT and metabolites)



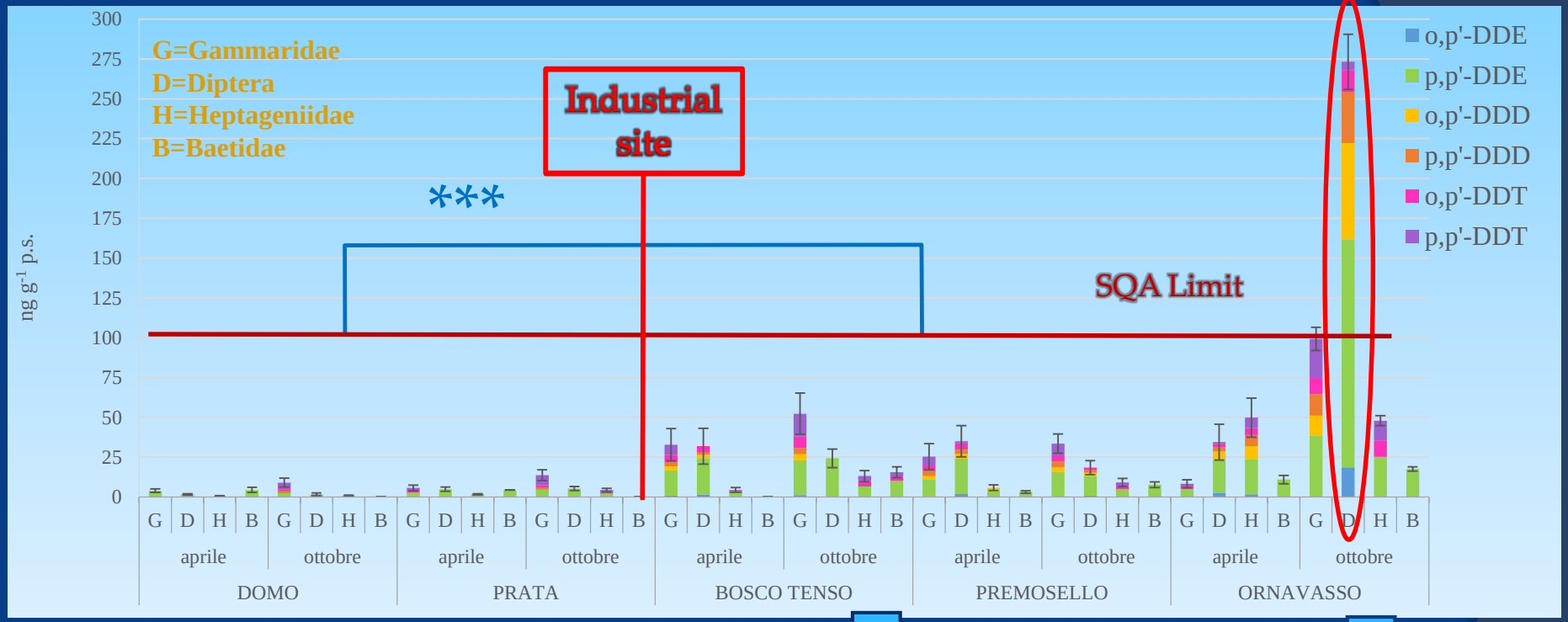
Premosello (April): concentrations

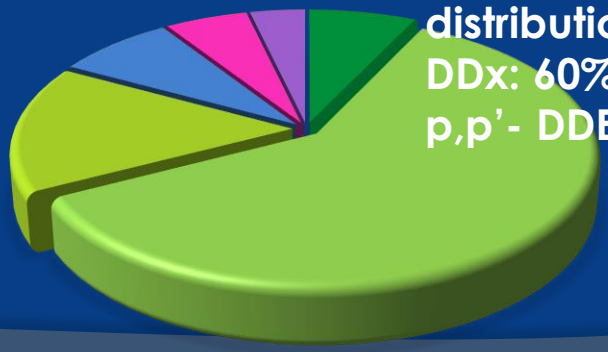
mean distribution of DDx: 80% of p,p'-DDT



DDx concentrations in sediments potentially toxic for benthic invertebrates

Behavior: bioaccumulation in benthic invertebrates of the Toce (DDT and metabolites)



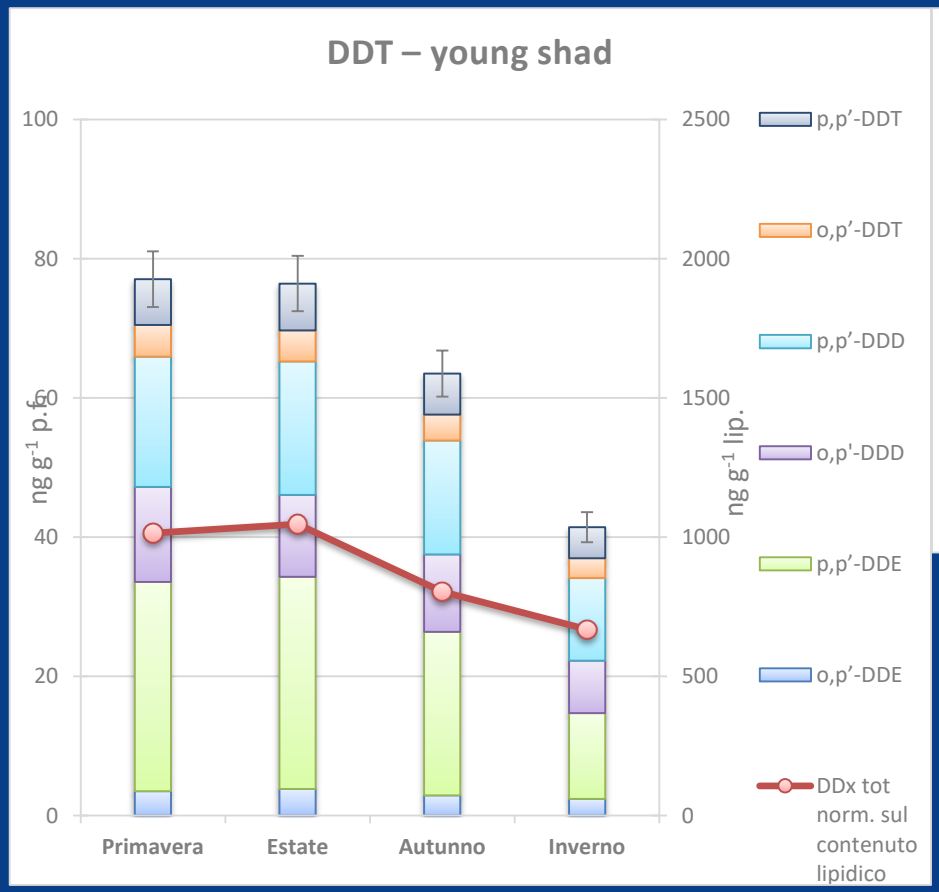


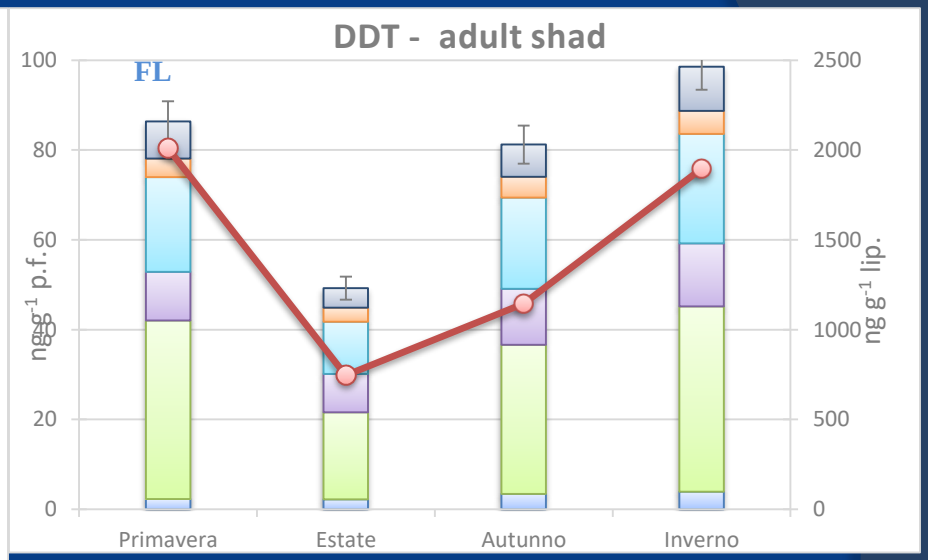
mean distribution of DDx: 60% of p,p'- DDE

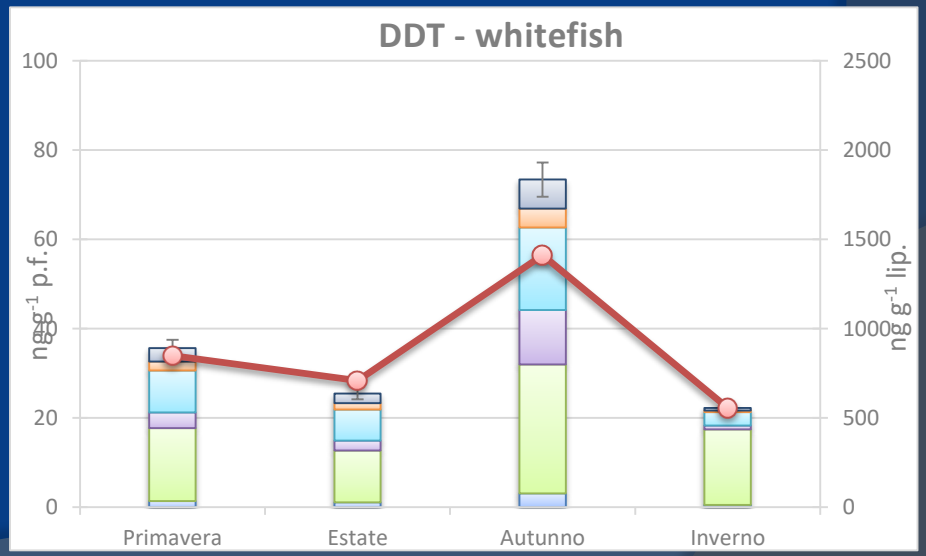
Significant difference between upstream and downstream the industrial site

According to Environmental Quality Standard for biota, Toce River is not in a good state

Fish: seasonal variability-physiological status



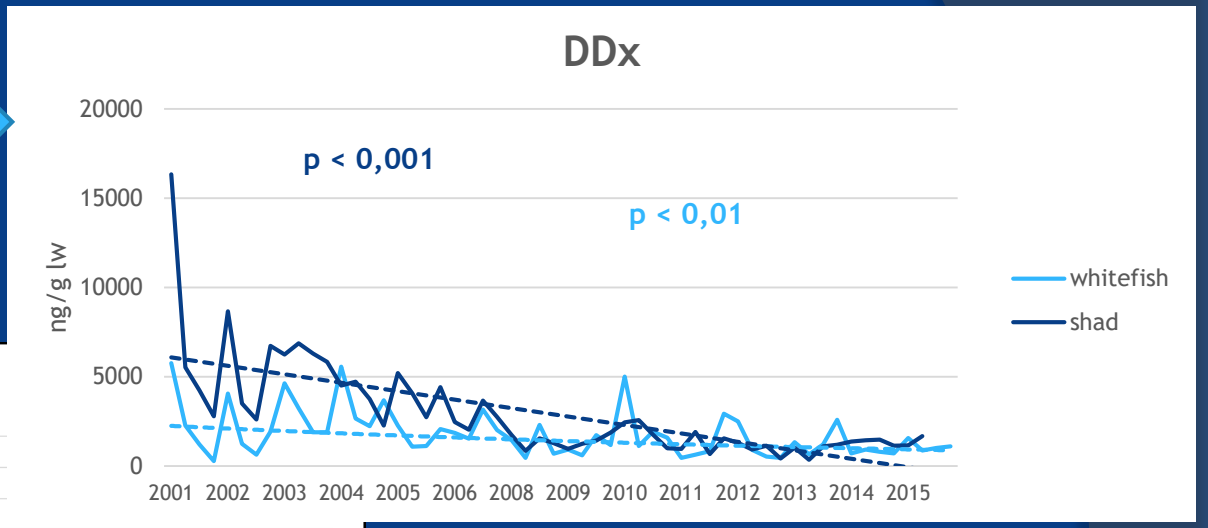


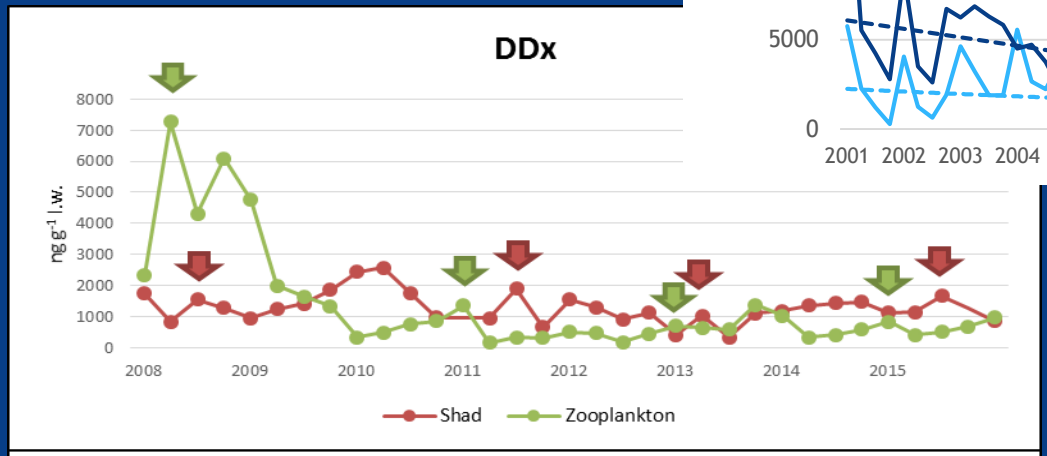


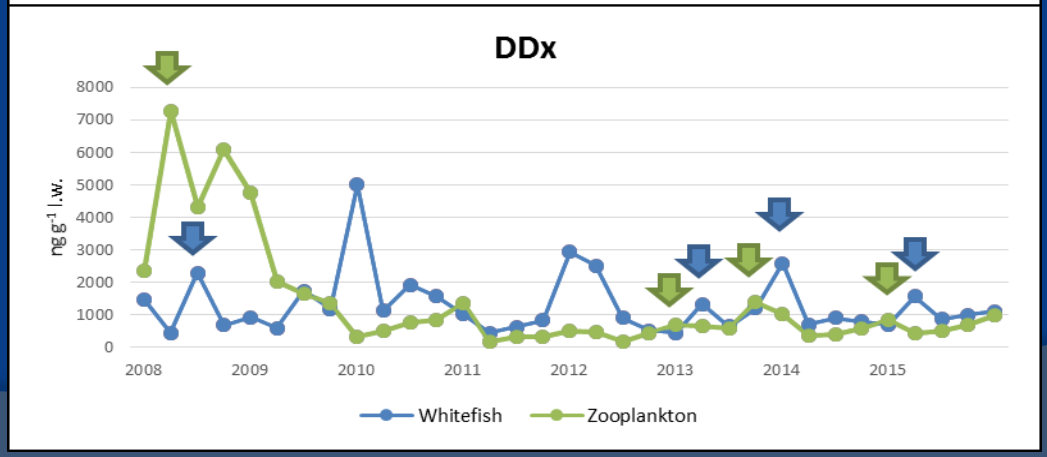
Bioaccumulation : trophic level, pre- o post-reproductive status, lipid content

Fish: temporal trends and trophic relation

Significant decrease of DDx values from 2001 to 2015 in both shad and whitefish





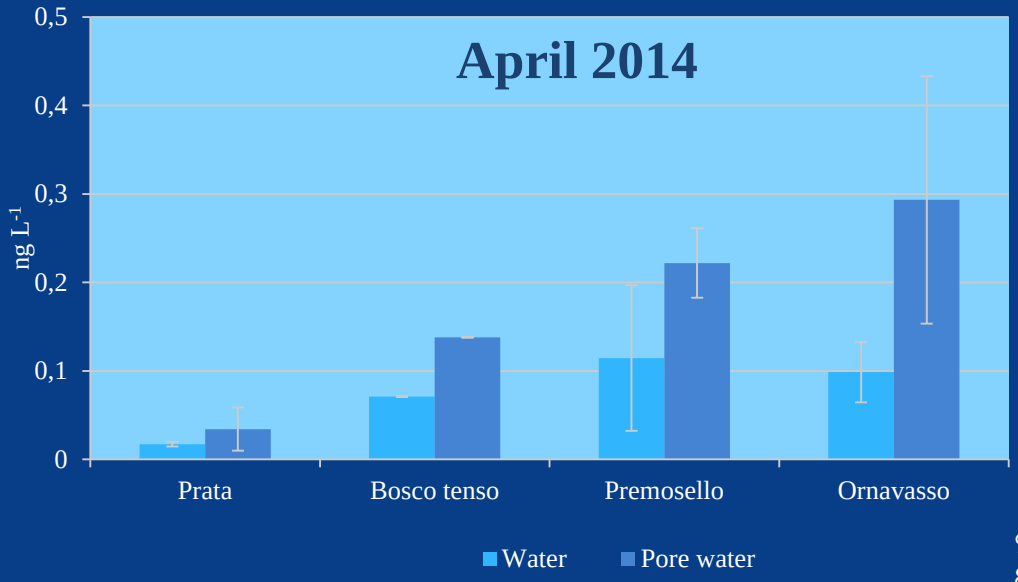


DDx peaks show a 3-6 months delay in comparison to peaks in zooplankton because a time span is necessary for trophic transfer

Behaviuor: Bioavailability

Bioavailability ***may identify environmental risk: passive samplers (as PED) can be used to estimate mean average concentrations in water and to predict site-specific contamination in biota. EU Directive recommends the use of passive samplers instead of spot water samples.***

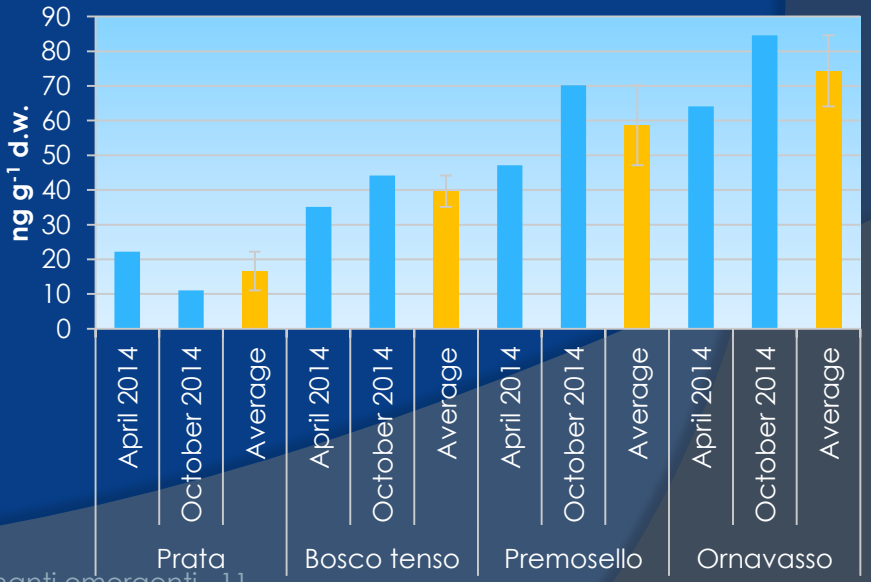
Bioavailability: use of PED samplers in Toce River



Polyethylene (PED) samplers estimate bioavailable water levels and sediment pore waters concentrations for DDx

Heptageniidae resulted as the best site-specific bioaccumator of DDx, showing a good with pore-water PED results

Macrobenthos: *Heptagenidae*



RISK : Ecological risk assessment (ERA)

Site of National Interest (SIN) of Pieve Vergonte (Piedoment Region): contamination of sediments and fish species of the Toce River and the Pallanza Bay (Lake Maggiore) for DDT and mercury.

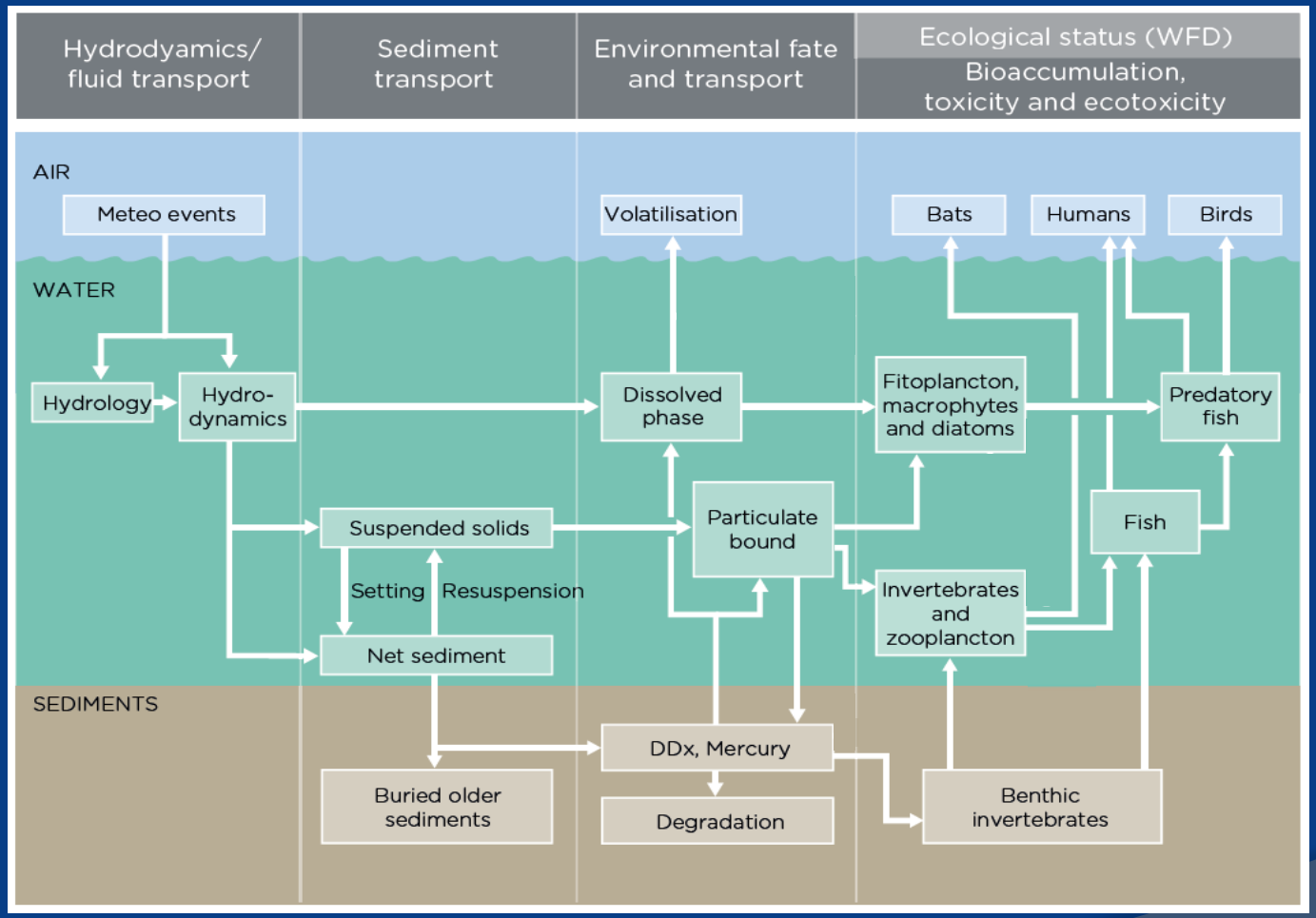
Which approach for the Ecological Risk Assessment (ERA)?

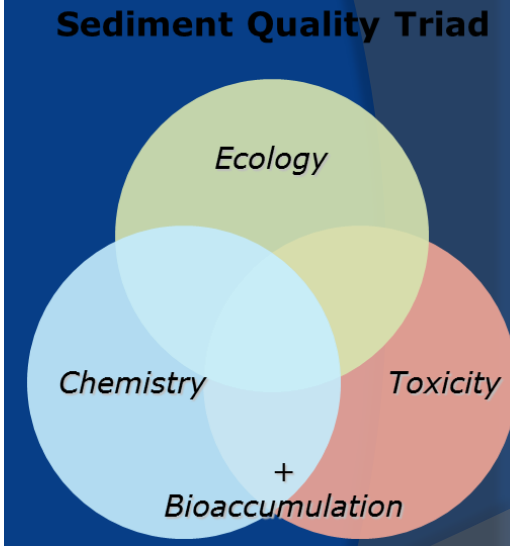
How to identify risk thresholds for each environmental compartment?

Definition of: conceptual model of the site; receptors and exposure pathways.

Industrial site at Pieve Vergonte

Site specific conceptual model





Environmental Risk Assessment (ERA) for a contaminated aquatic ecosystem

Analysis of sediments and water in the aquatic ecosystem

Evaluation of pollutant contamination in sediment and waters

Conceptual Site Model

Definition of screening benchmarks

Definition of risk benchmarks

Analysis of bioavailability for biota

Evaluation of contaminant in benthic organisms

Direct effects on biota

Direct effects on biota and secondary poisoning

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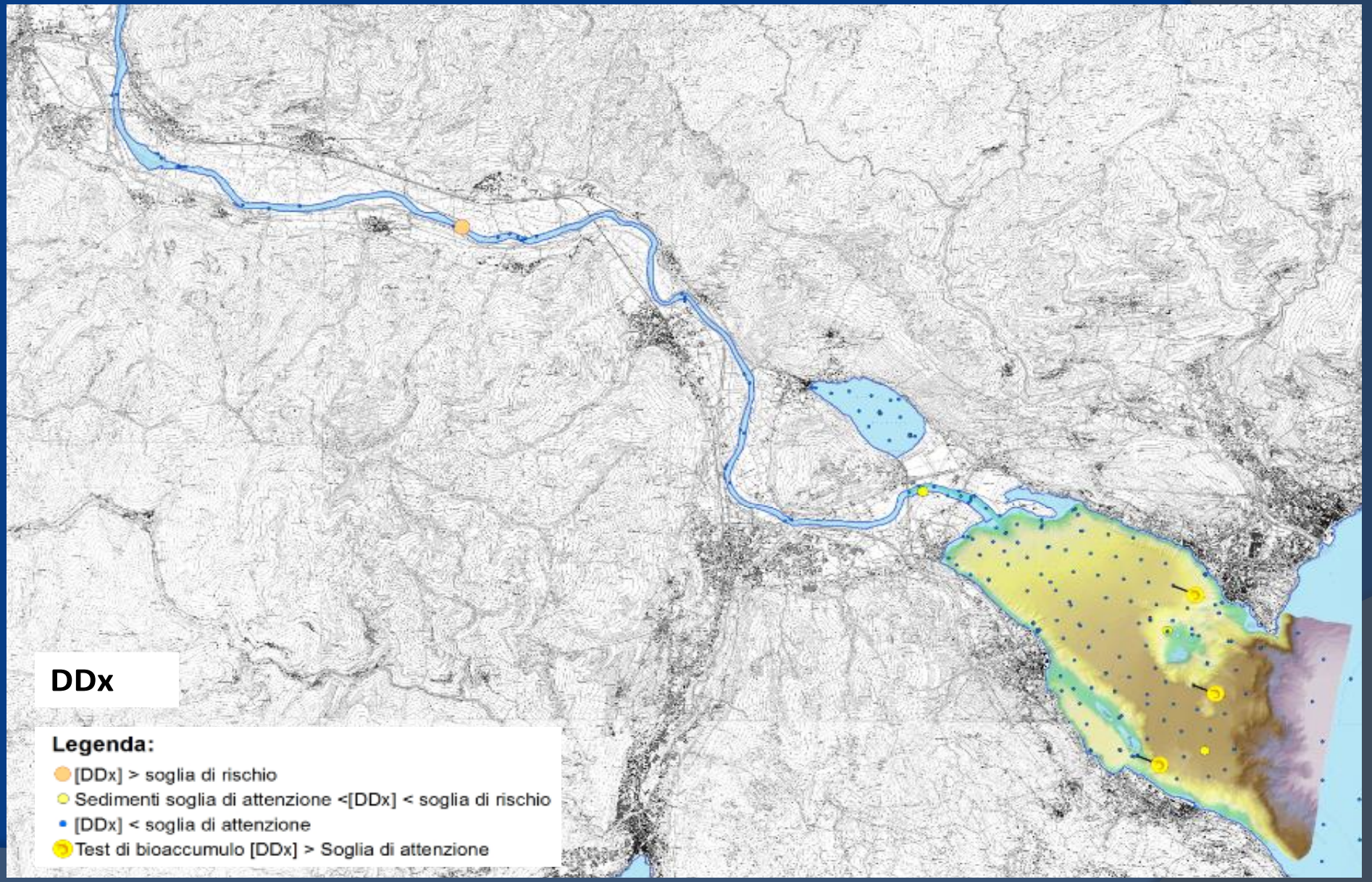
Comparison between on-site data and benchmarks: DDx



Conclusion and management directions: DDx

Sediment Quality Triad for DDx							
	Benthos				Fish or other aquatic organisms		*Secondary poisoning*
	Sediments	**Benthos Tissues**	**Toxicity tests**	**Ecological status**	**Waters**	**Fish tissues**	**Fishing birds or bats**
Lake Maggiore	Exceedance of attention benchmarch	Exceedance of attention benchmarch	No toxic effetcs	Sufficient Ecological status	No Exceedance of risk benchmark	No Exceedance	No Exceedance of risk benchmark
Toce River	**One Exceedance of risk benchmark in 2009 and of attention benchmark**	No Exceedance	Some toxic effects on *C. riparius and* on algae test upstream and downstream the industrial site	Sufficient Ecological status	No Exceedance of risk benchmark	No Exceedance	

Exceedance of risk benchmark or toxicity

Exceedance of attention benchmark or toxicity not correlated with DDx and Hg levels

No Exceedance

Conclusions

Monitoring Strategy

For each specific water body, pressure analysis drives selection of contaminants, followed by

- ***matrices of concern (water, sediment, biota)***
- ***studying temporal and spatial variability***
- ***evaluation of trends,***
- ***for biota: trophic levels, exposure mode, …***

Behavior

- ***Bioavailability (main strategy)***
- ***toxic effects measured at different level of biological organization***

Risk for human health and ecosystem impact

What else? Working for improving knowledge and developing new technology ! ! !

THANK YOU !