Environmental risk assessment of contaminated sediments

WSP

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Report soon on
www.naturvardsverket.se
…..Hallbar-sanering/

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Major goals

- A generic strategy for assessing environmental risks of contaminated sediments
- Briefly review methods for:
  - *transport*
  - *exposure*
  - *bioaccumulation*
  - *toxic effects*
- The study does not
  - cover health risks
  - suggest specific guidevalues
  - risks during remediation

Starting point

A sediments is contaminated – does it pose any risk??

Measured concentrations in sediments ≠
the exposure that organisms experience

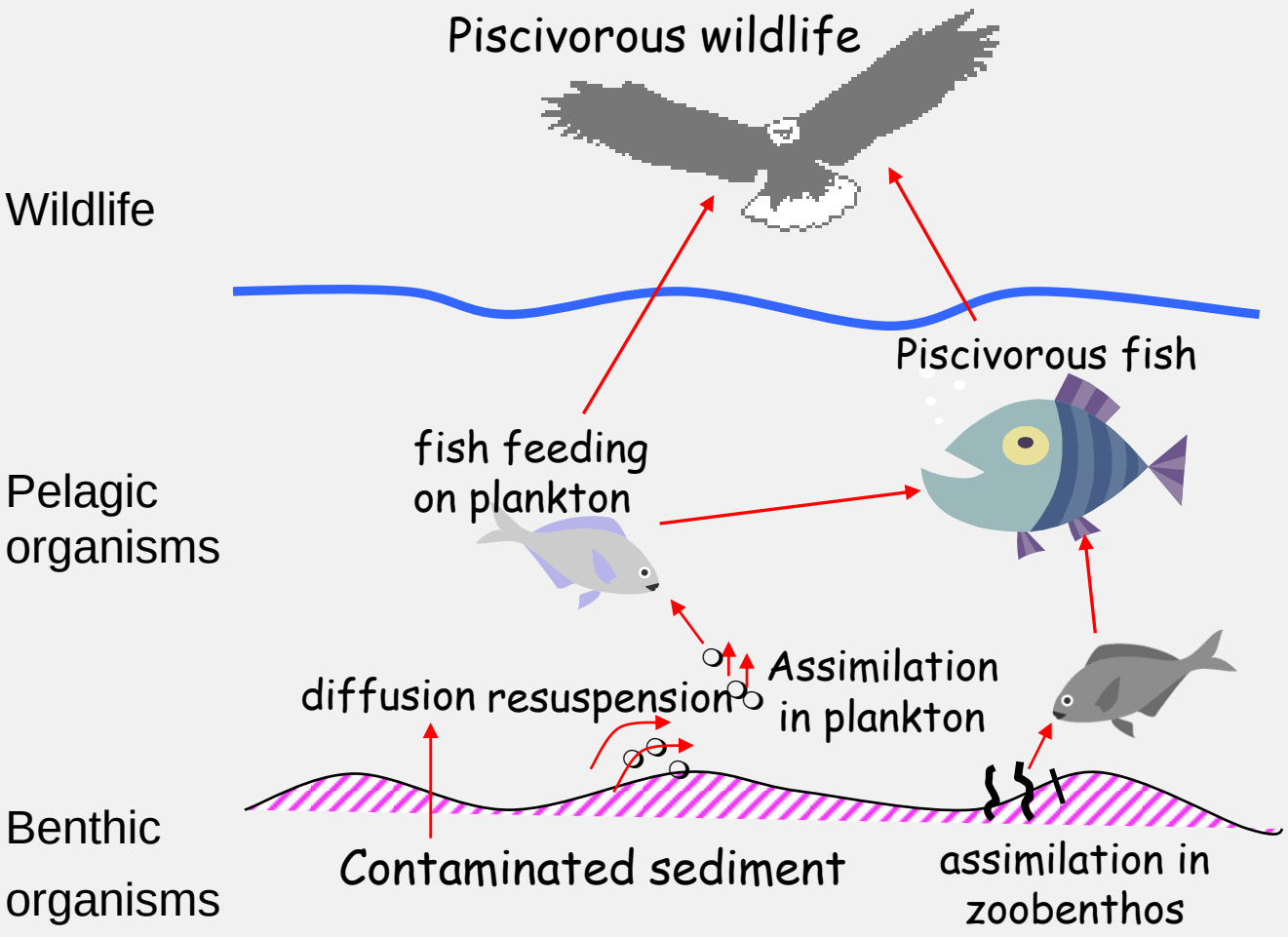
Why not?

- Numerous physicochemical fractions
- Bioavailable fractions vary with species, site, (time)
- Food-chain transfer is not a simple function of sedimentary concentration

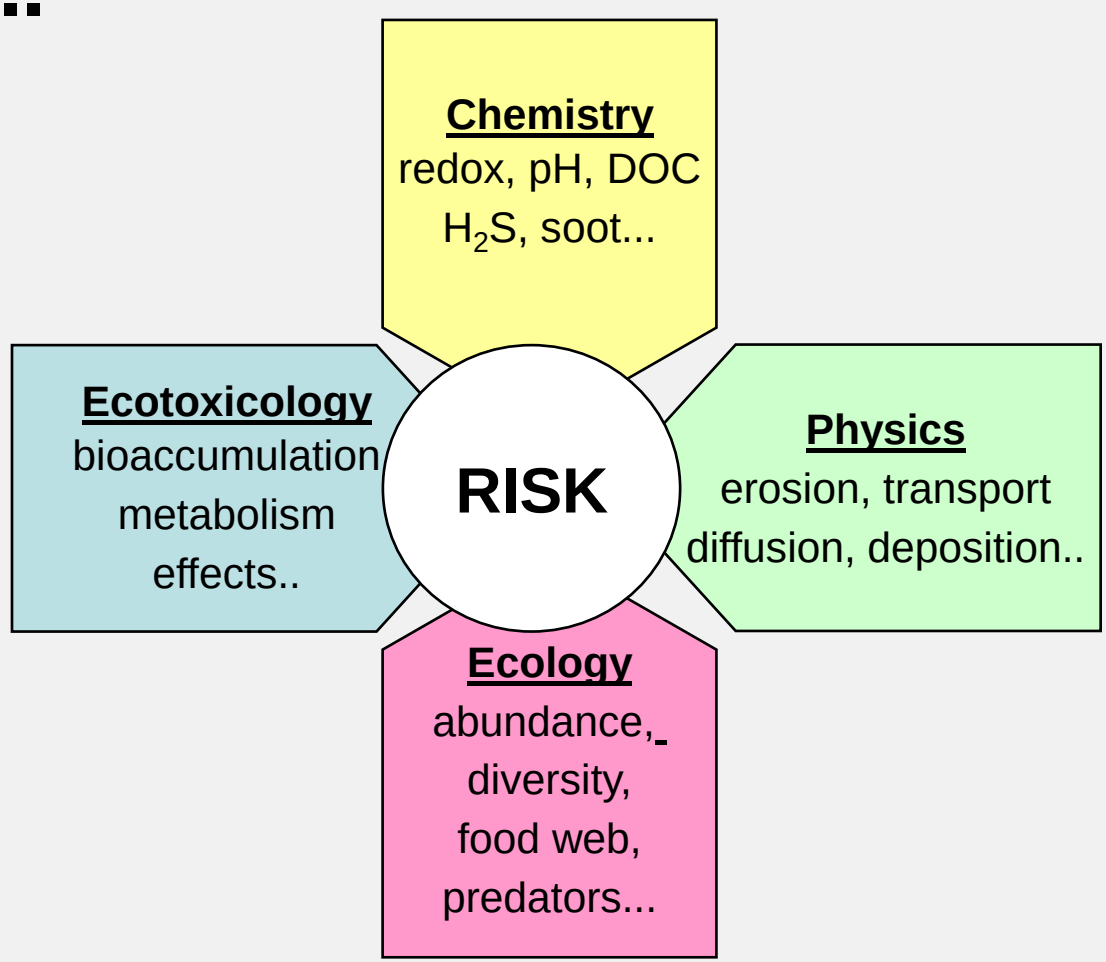
Commonly used guidevalues differ by orders of magnitude

General sedimentary guidevalues poorly predict ecological risks!

Pollutant transfer from sediments



Site-specific factors contribute to risk...



Basic strategy

Identify the critical receptors for the site:
benthos, pelagic, wildlife

Characterise the risk where it is likely to occur:
choice of methods = f(site; pollutant)

Investigate the causal relationships between sediments and effects/risk

Process

1. Problem description
2. Exposure analysis
3. Effect analysis
4. Risk characterisation

1. Problem description

- ✓ Potential pollutants
- ✓ Potential receptors
- ✓ Conceptual model
- ✓ Select approach(-es)

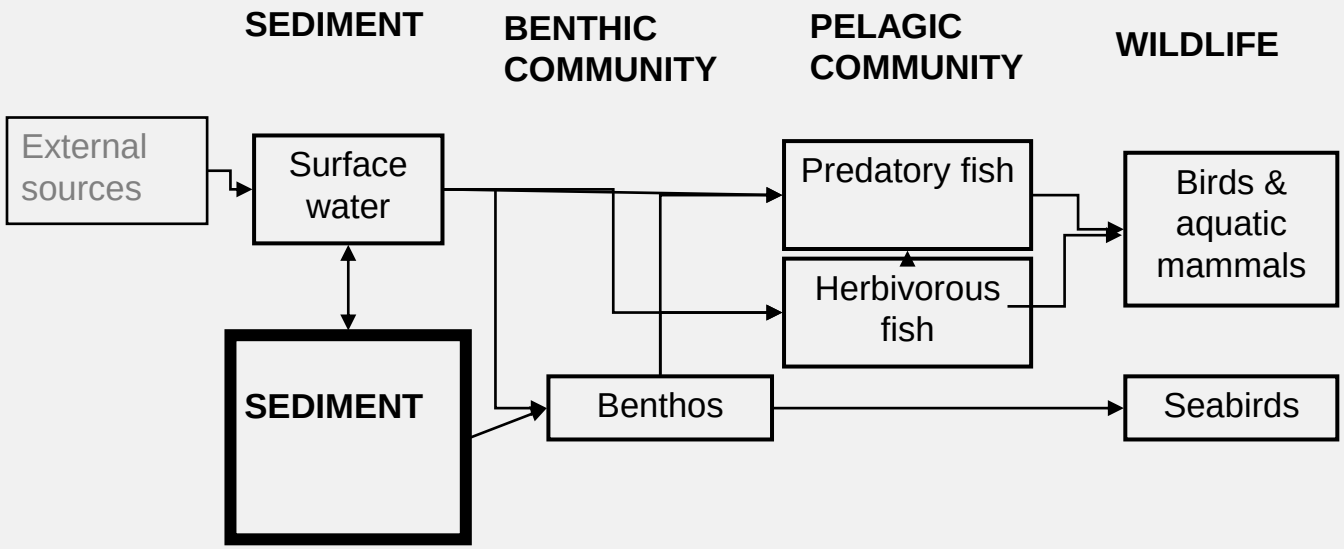
⇓ benthic ⇓ pelagic ⇓ wildlife

Pollutants and critical receptors

	Benthic	Pelagic	Wildlife
Metals			
Methyl-mercury			
Labile organic compounds			
PBT-substances			

Site-specific conceptual models

- All sources of contamination
- Potential contaminants
- Receptor groups
- Transport & exposure pathways



Selecting approaches

- Suitability vary with pollutant and with receptor
- Proof-of-evidence & uncertainties vary between different approaches
- Choose media that reflects the potential risks
- Complementary approaches is a strength!

Different receptors require different approaches

APPROACH	Benthic	Pelagic	Wildlife
Sed. chemistry & effect levels	x		
Ecotox. tests	**X**	x	
Biological surveys	**X**	x	x
Physiological investigations	**X**	**X**	
Levels in biota & corr. effect levels	x	**X**	**X**
Biomarkers	x	x	

2. Exposure analysis

- Characterise the pollutant source
- Identify transport pathways
- Quantify exposure at the critical receptors

- **Benthos**: bioavailable; porewaters; internal levels; biomarkers

- **Other organisms**:

Pollutant	Exposure fish	Exposure wildlife
♦ Metals & labile organics	Conc. in surface water or in food	Not relevant
♦ Methyl-mercury	Conc. in organisms	Calculate dose
♦ PBT-substances	Conc. in organisms	Calculate dose

3. Effect analysis

- **Effect-based guidevalues**
  - (sediments)
  - water
  - biota
- **Ecotoxic tests**
  - mainly for benthos and pelagic / fish
- **Biological investigations**
  - individual: biomarkers, morphology ...
  - population: abundance, age structure...
  - ecosystem: range, diversity...

4. Risk characterization

- Evaluate exposure vs. effects
- Evaluate causal relationships
- Uncertainties
- Use multiple approaches
- Weight of evidence

Example of evaluation - benthos

Sed. chem. vs guidevalues	Ecotox tests	Biology	Interpretation
–	–	–	No risk
+	–	–	No risk
–	+	–	Potential risk, detailed studies to identify causes
–	–	+	The sed. pollutants are not likely the cause of biol. dev.
+	+	–	Potential risk
–	+	+	Risk! Identify causes of biol. & tox. response
+	–	+	Potential risk, detailed studies to identify causes of biol. resp.
+	+	+	RISK!

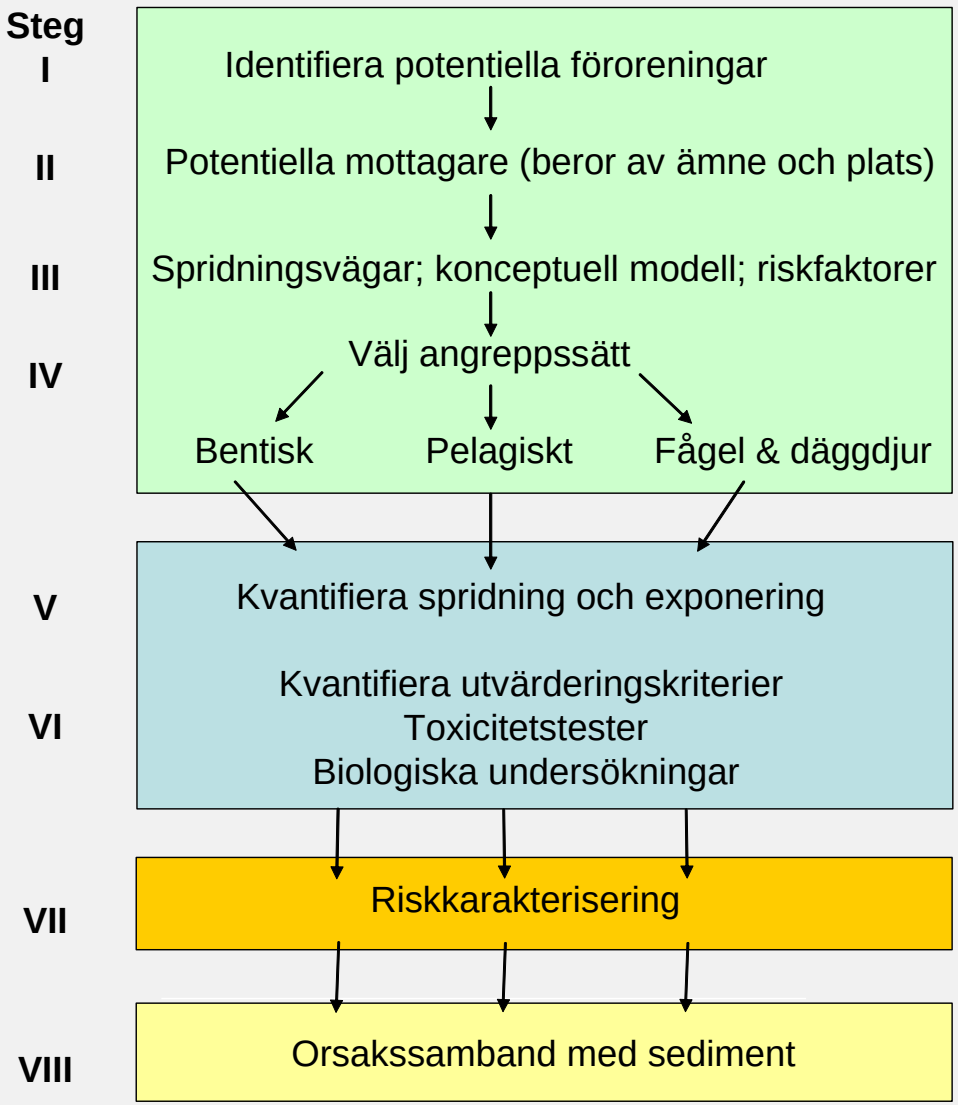
Summary

1. **Problem description**

2. **Exposure analysis**

3. **Effect analysis**

4. **Risk characterisation**



Conclusions

- Different pollutants – different strategies
- Investigations focus on exposure and effects
- Initial focus on risk *where it may occur*
- Multidisciplinary approach
- Causal relationships to sedimentary pollutants later
- Guidevalues for sediments poorly predict risks
- Local reference data are important for
  -concentrations
  - biology