Copper in Antifouling

The EU marine risk assessment process

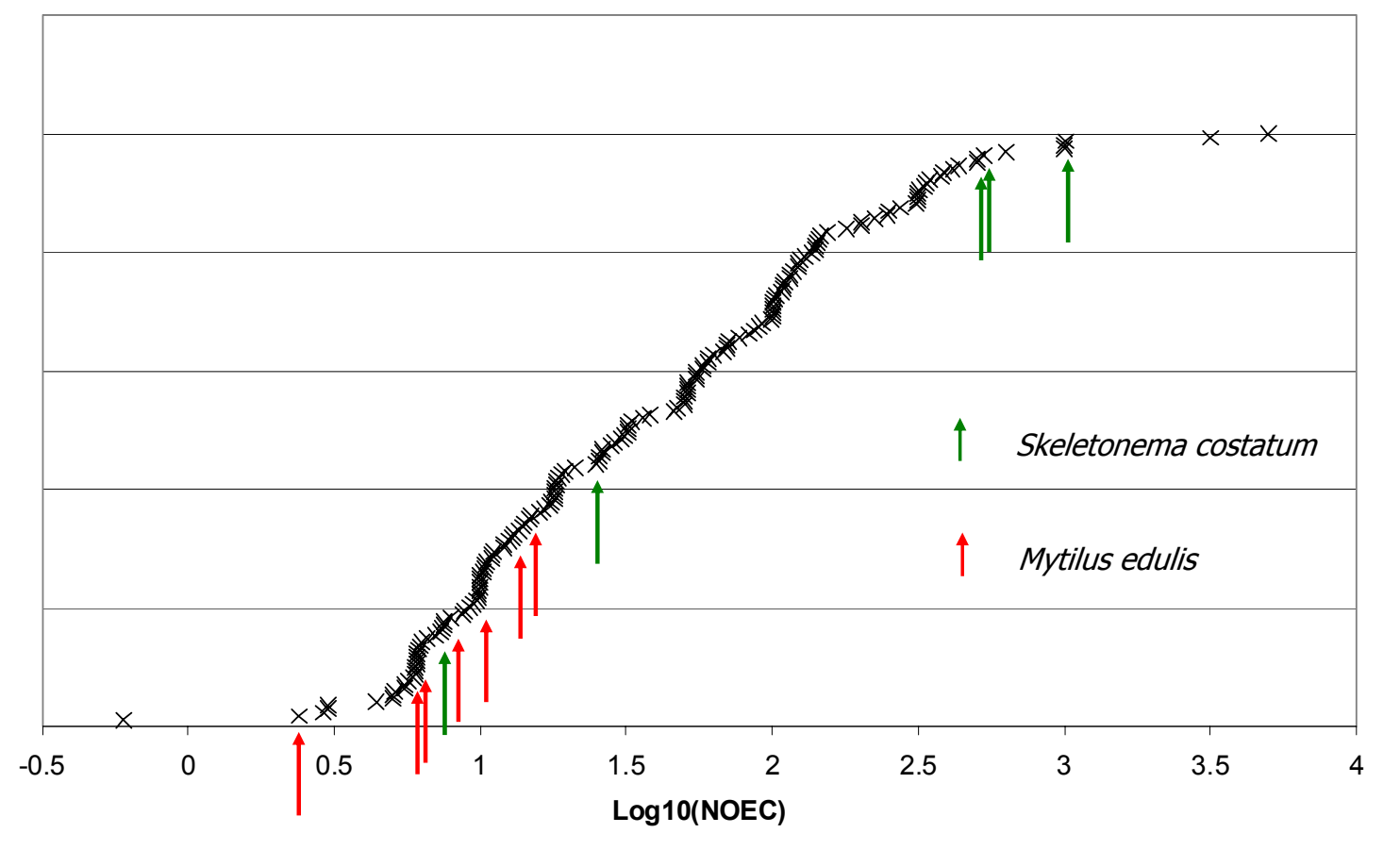
Copper in Antifouling

- Regulatory Drivers
  - Biocidal Products Directive (98/8/EC)
  - Existing Substances Regulation (793/93/EEC)
- Industry-led initiative
  - EU Antifouling Copper Task Force
  - European Copper Institute

The problems (1)

- Database of over 150 chronic endpoints, 70 species
- No Observed Effect Concentrations (NOECs) range from 1 µg/l to 5 mg/l

The problems (1)

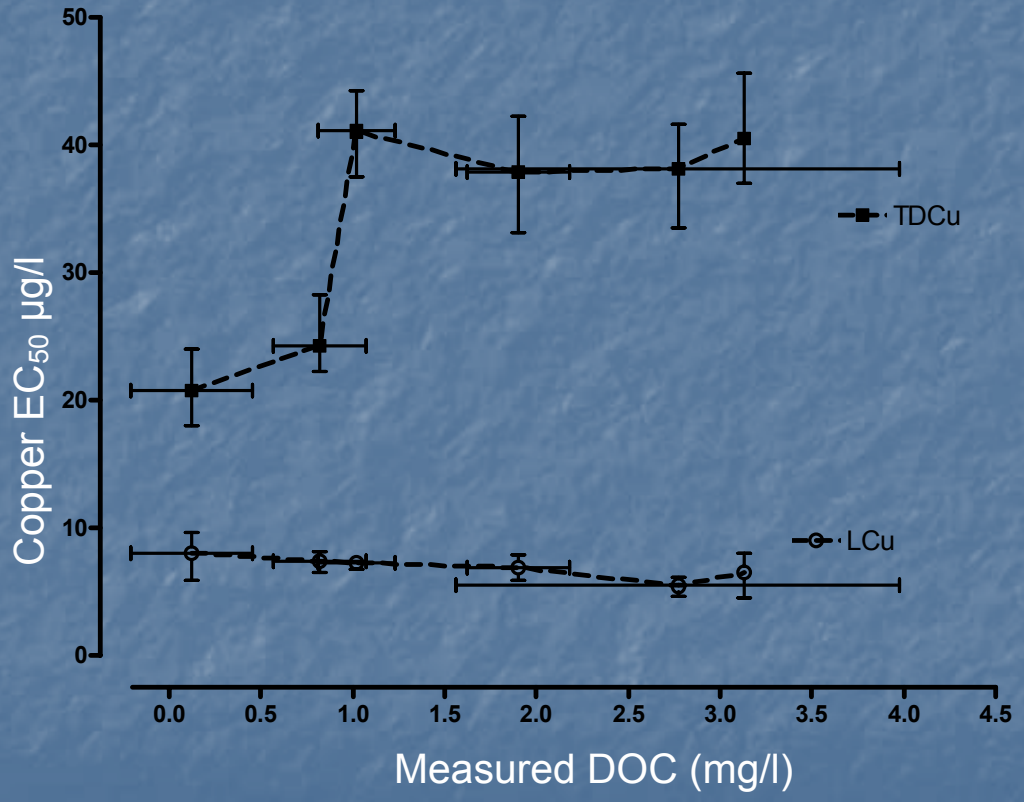


NOEC values reported in
μ g/l

The problems (2)

- Waldock, Rio 2006
  - Copper toxicity to *Crassostrea gigas* (pacific oyster) embryos
  - Copper toxicity to *Fucus vesiculosus* (bladderwrack) germlings
- Both studies showed:
  - ↑ dissolved organic carbon (DOC)
  - ↓ observed toxicity

Copper toxicity to *Crassostrea gigas*

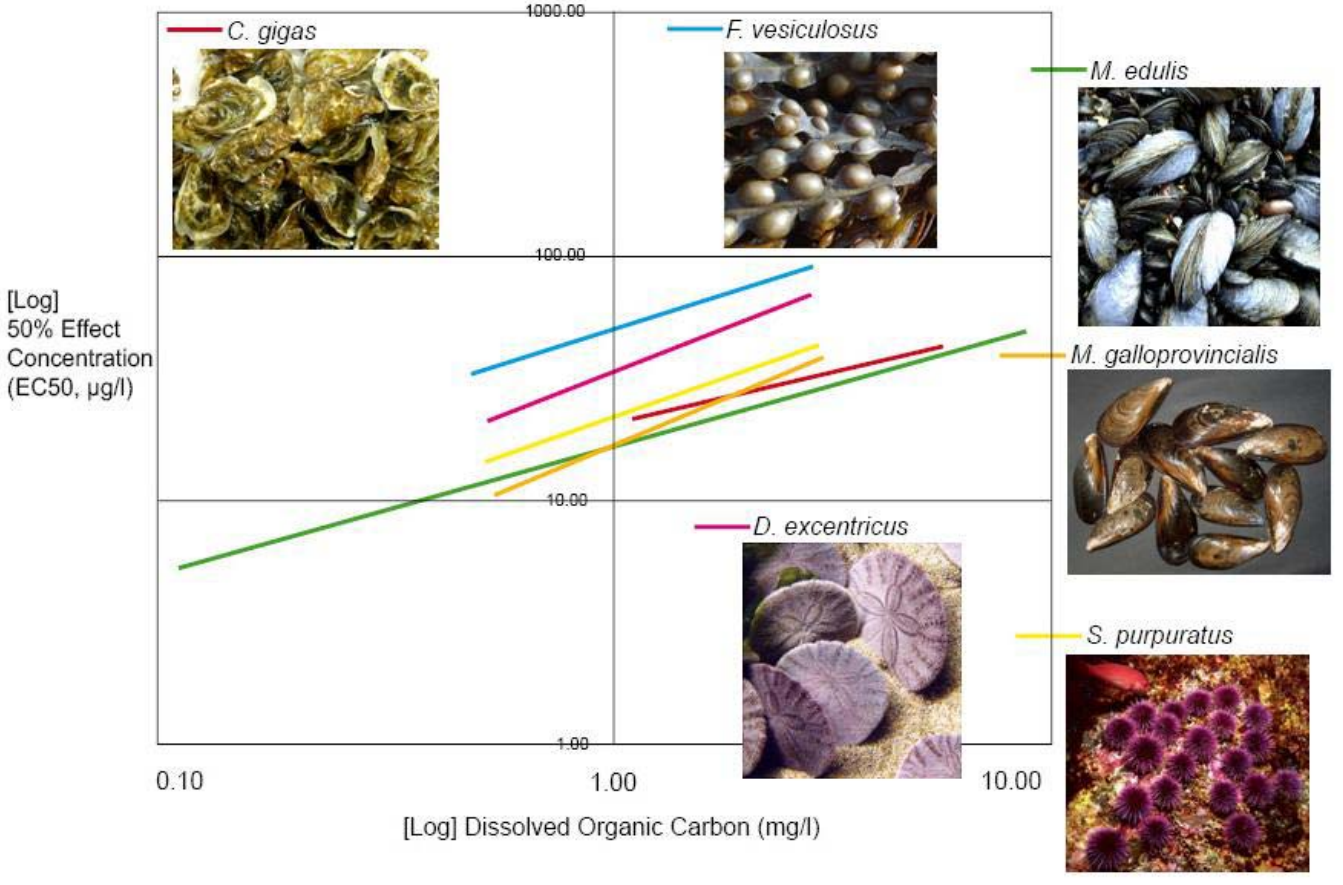


The problems (2)

- Bioavailability is critical to toxicity
- How to define a safe level, incorporating a measure of bioavailability?

The solution?

- Does DOC correlate with toxicity across species?


1000.00
100.00
10.00
1.00
C. gigas
F. vesiculosus
M. edulis
M. galloprovincialis
D. excentricus
S. purpuratus
[Log]
50% Effect
Concentration
(EC50, µg/l)
0.10
1.00
10.00
[Log] Dissolved Organic Carbon (mg/l)

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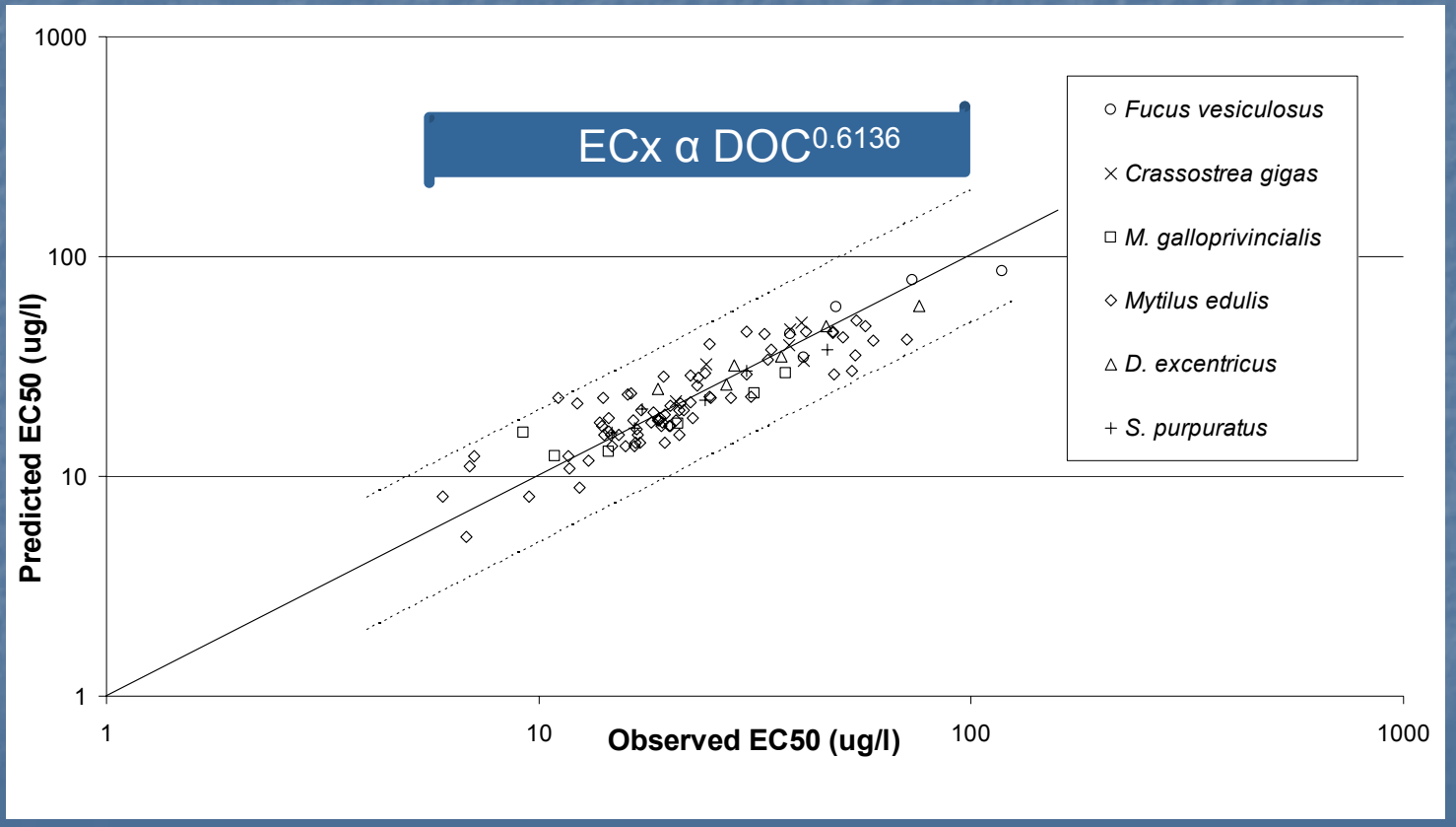


Copper in Antifouling

- How can we use this correlation to define a safe level for use in risk assessment?
  - Onshore vs. open ocean DOC levels
  - Results from ecotoxicity tests are at many different DOC concentrations

The process (1)

- Marine database
- Quality review (eg. replication, analysis, control response)
  - 56 NOEC values
  - 24 species
  - 8 taxonomic groups

The process (2)

1. Normalised for 3 "typical" scenarios
   - MAMPEC "open ocean" (0.2 mg/l DOC)
   - "onshore" (0.5 mg/l DOC)
   - MAMPEC "marina/harbour" (2 mg/l DOC)
2. Calculate species (geometric) means

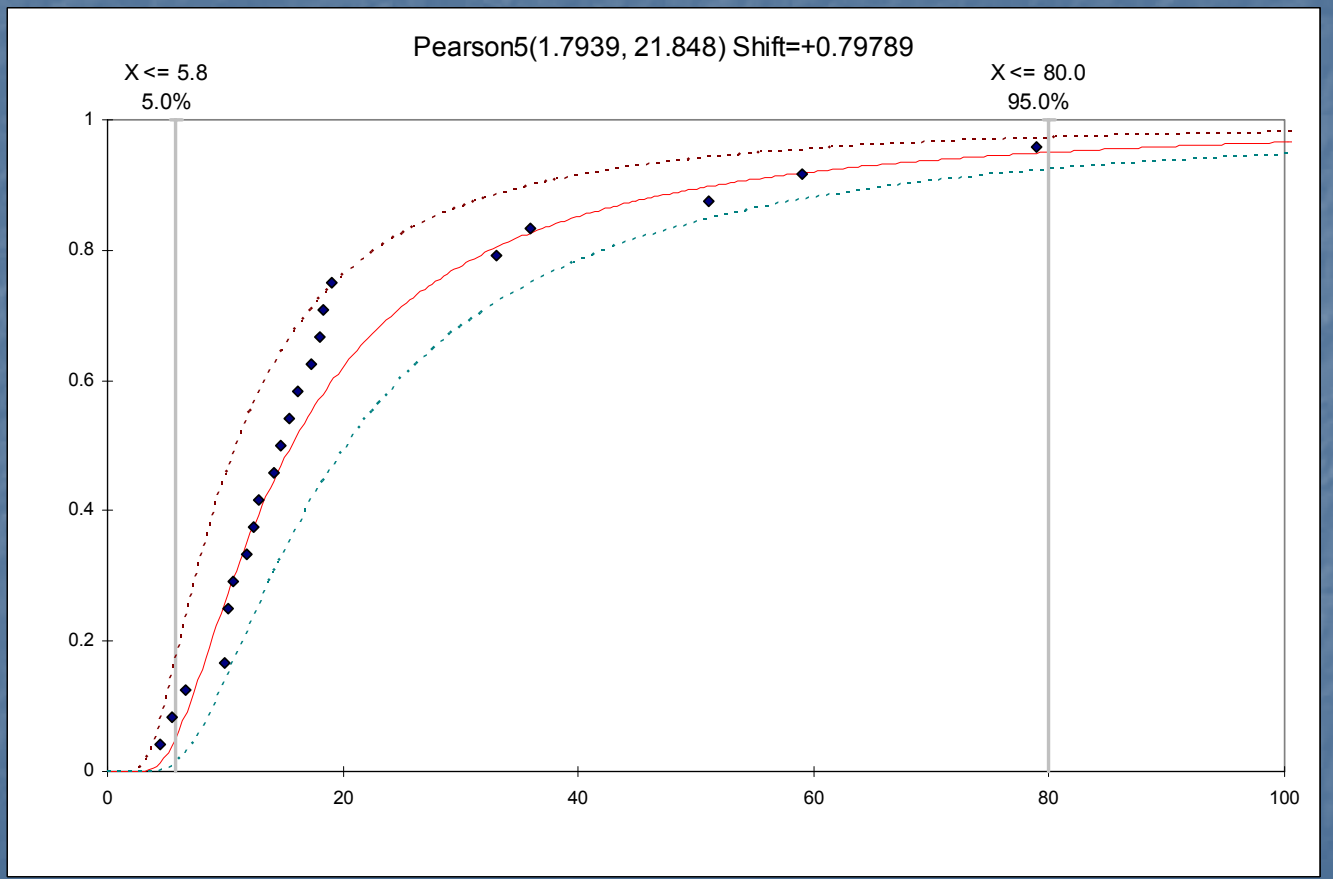
The process (3)

- Example – The Fucus dataset
  - 5 NOECs (11 – 48 µg/l) at different DOC concentrations (1.05 – 2.88 mg/l)
  - Normalised to 2 mg/l DOC reduced the range 12 – 26 µg/l
  - Geometric (species) mean value 18.3 µg/l

The process (4)

1. Generate a "Species Sensitive Distribution" for each scenario
2. Derive 5th percentile (HC5-50) values

What are HC5-50 values?



What do we get?

- HC5-50 values for three "typical" scenarios
- A correlation to enable site-specific risk assessments based upon a simple measurement of Dissolved Organic Carbon

DOC	HC5 (µg l^{-1})	HC5-50 (µg l^{-1})
0.2 mg/l	1.4	1.3
0.5 mg/l	2.4	2.3
2.0 mg/l	5.8	5.2

Is there a problem?

- The Risk Characterisation Ratio (RCR) is defined as;

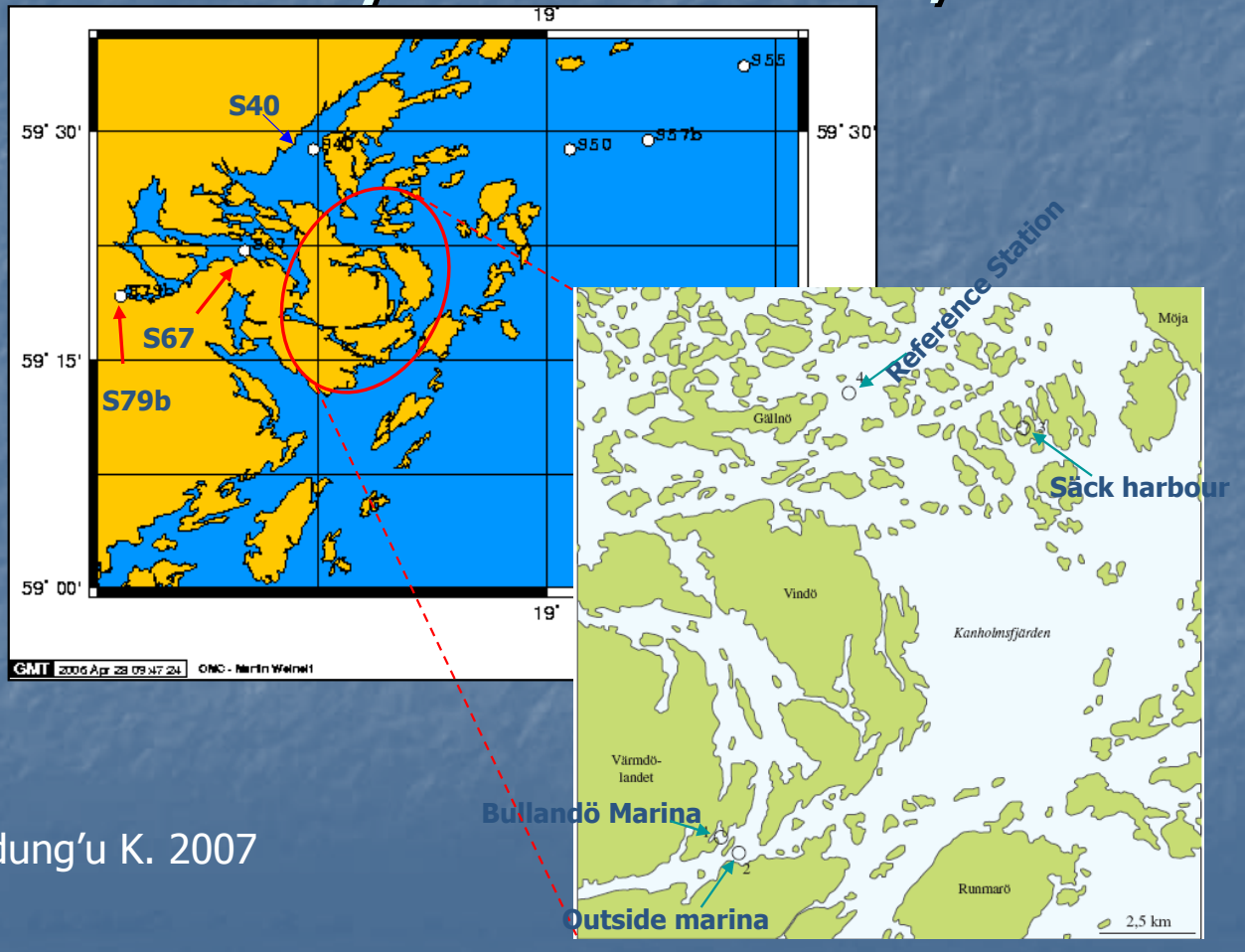
$$\frac{\text{Predicted (or Measured) Environmental Concentration (PEC/MEC)}}{\text{Predicted No Effect Concentration (PNEC)}} > 1 = \text{Risk}$$

  - We have a "safe" level of 5.2 µg/l if the DOC concentration is 2.0 mg/l
  - What do our monitoring data (MECs) tell us?

Site-specific risk assessments

- Collect reported data from monitoring studies in EU marinas where DOC and dissolved copper levels have been measured
- Calculate site-specific “safe levels” based on DOC
- Do measured concentrations exceed these “safe levels”?

Case Study 1: Bullandö, Sweden

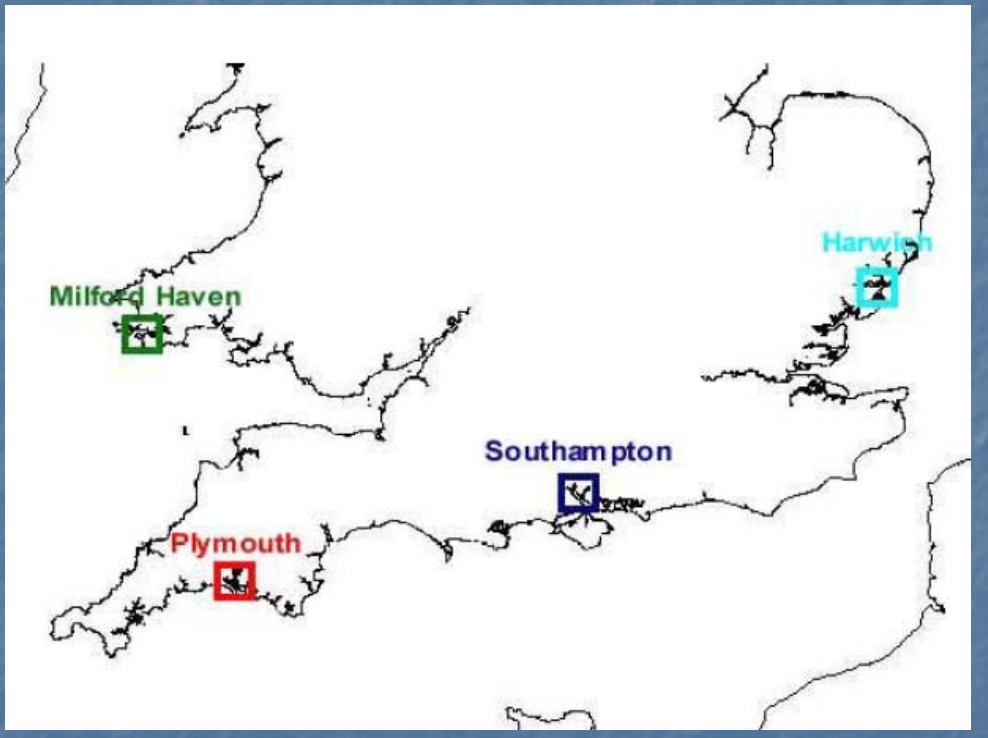


Ndung'u K. 2007

Results: Bullandö, Sweden

	DOC mg/l	Cu µg/l	Safe level s/s	RCR
S-67	4.66	1.40	8.733	0.160
S-50	3.96	0.51	7.907	0.064
Reference station	4.09	0.84	8.068	0.105
Säck Harbor	4.36	0.90	8.384	0.108
Outside Bullandö	4.44	1.04	8.483	0.123
Bullandö Marina	4.40	3.16	8.440	0.374

Case Study 2: UK



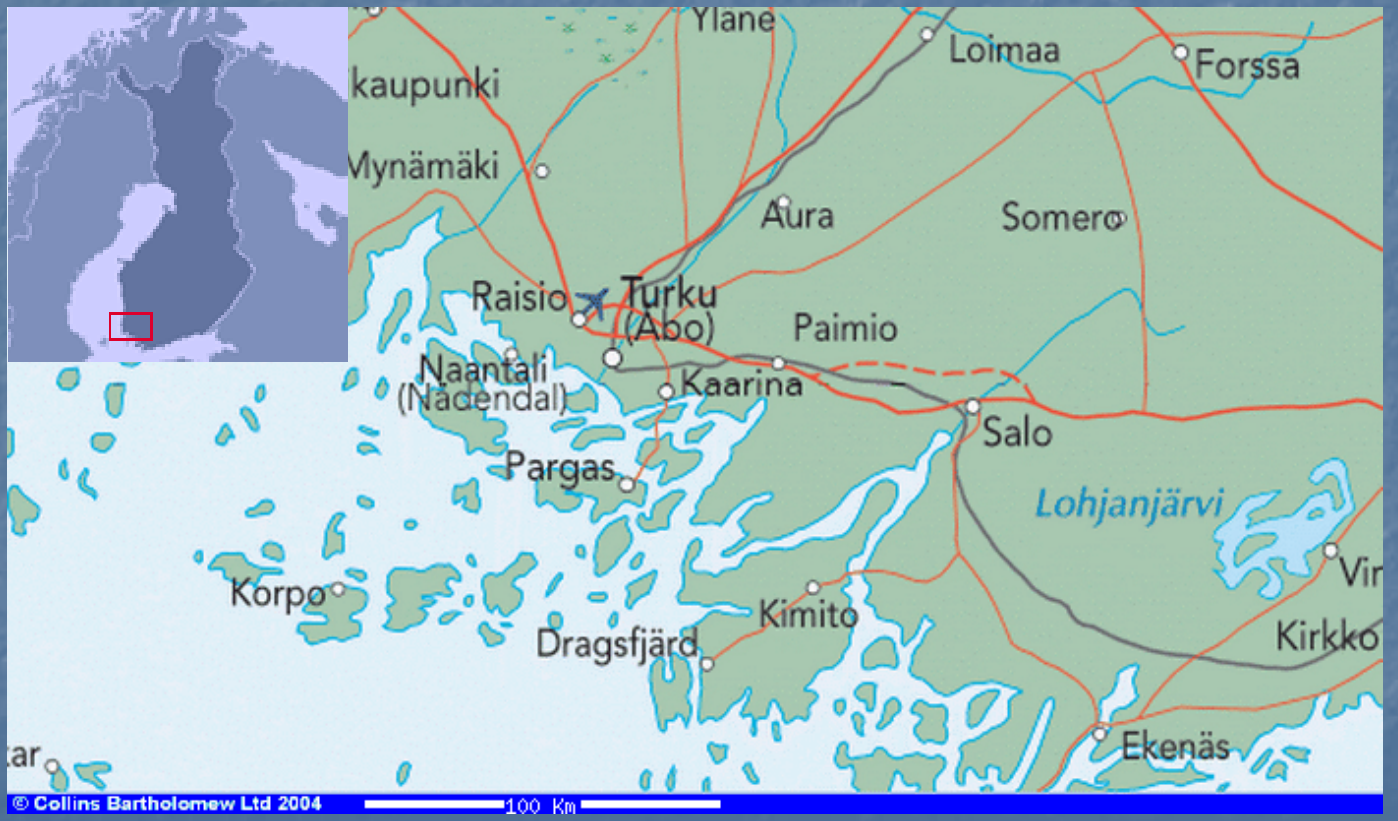
Jones B et al., 2007


Queen Anne's Battery
Ocean Village
© 2008 Tele Atlas
Neyland Marina

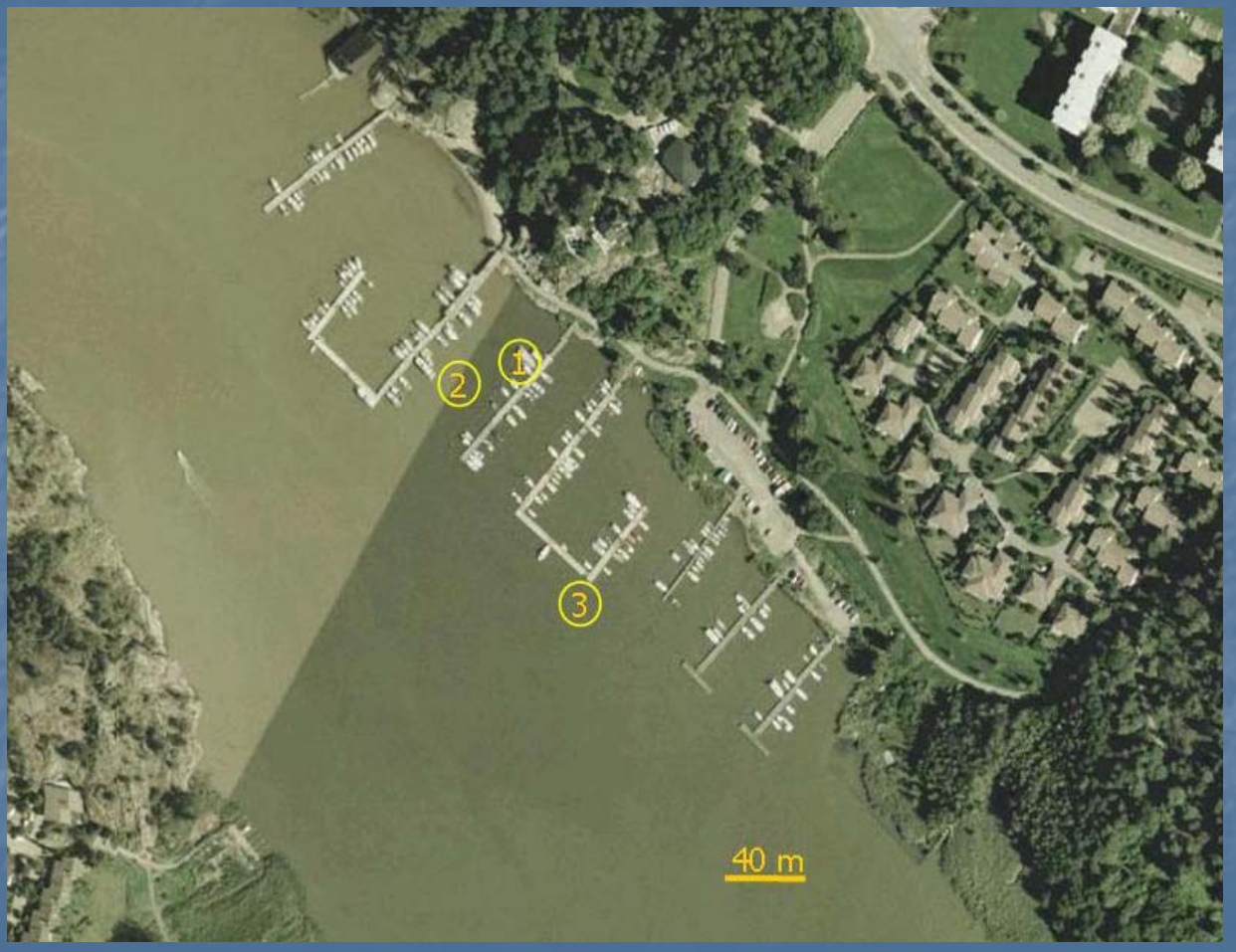
Results: UK

- Mean RCR 0.423
- Maximum RCR 0.919
- Minimum RCR 0.139
- 95th percentile 0.720
- 5th percentile 0.200
- Number of data 36

Case Study 3: Turku, Finland



Brooks S et al., 2007


1
2
3
40 m

Results: Turku, Finland

- Mean RCR 0.191
- Maximum RCR 0.416
- Minimum RCR 0.069
- 95th percentile 0.362
- 5th percentile 0.090
- Number of data 16

Conclusions (1)

- From available data, a correlation can be drawn between observed toxicity and DOC concentration
- Using this correlation, a "safe" level of 5.2 µg/l at 2.0 mg/l DOC can be derived using statistical extrapolation

Conclusions (2)

- For antifouling use, marina data should present the worst case for risk of adverse effects due to copper exposure
- Available marina data indicate that, within the EU, the use of copper in antifouling paints is not leading to levels of concern

Thank you for your attention

Further information can be found at:

www.copperantifouling.com

Copper Antifouling Environment Programme (CAEP)