Water pollution by antifouling as a driver for Earth system changes in the Baltic Sea region

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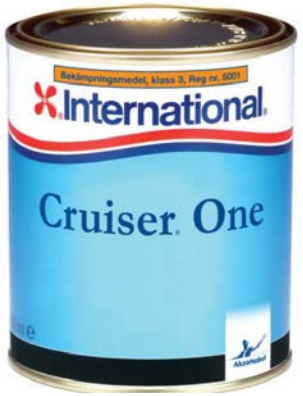
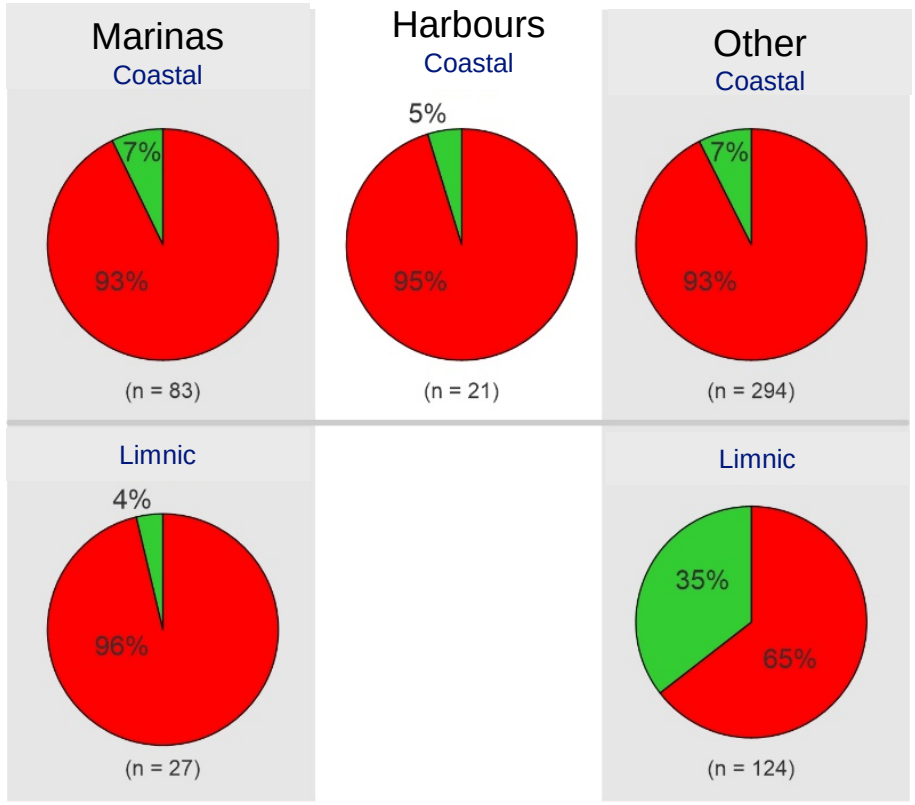
Biocidal use in antifouling coatings

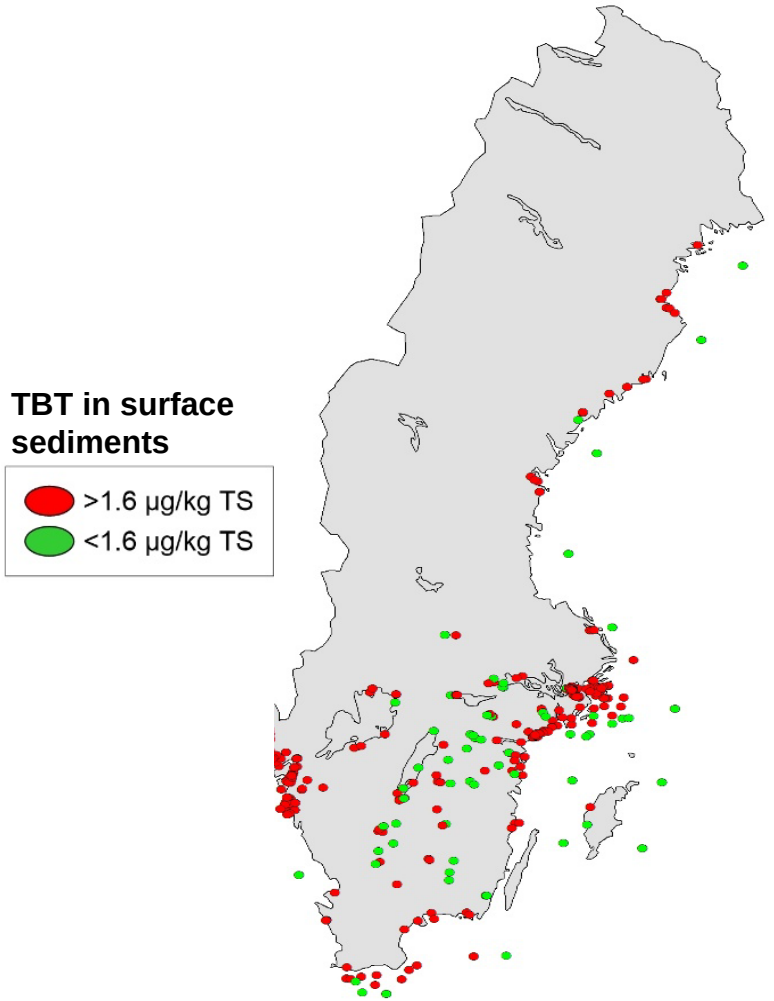
- **1970s-90s - Organotin compounds, TBT (tributyltin)**
  - Prohibited for leisure boats in EU 1989
  - Prohibited for ships in 2008 (AFS convention)

- **2000-present – Copper compounds**

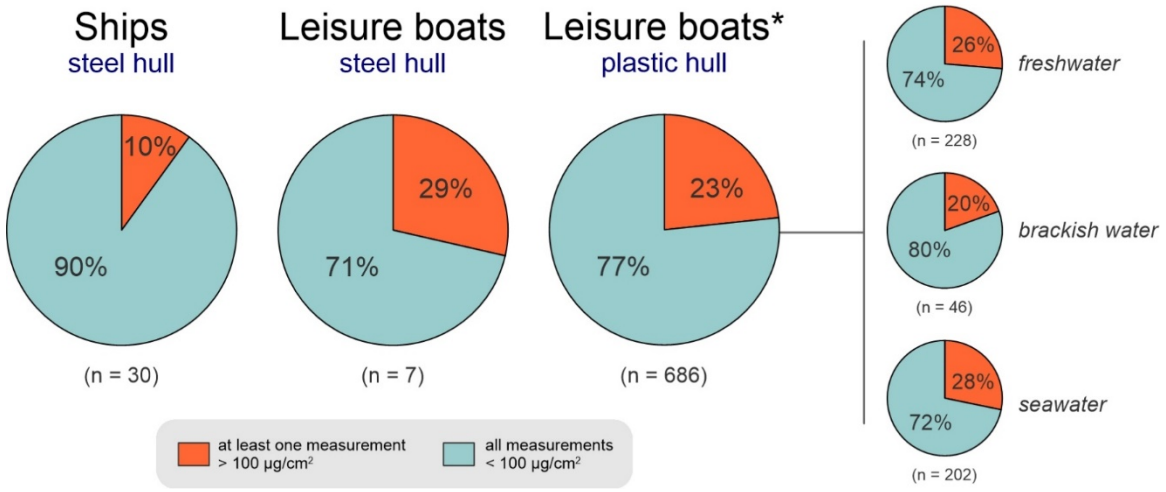


Status classification – TBT in Sediments





Sn (organotin compounds) on ships and leisure boats in Sweden



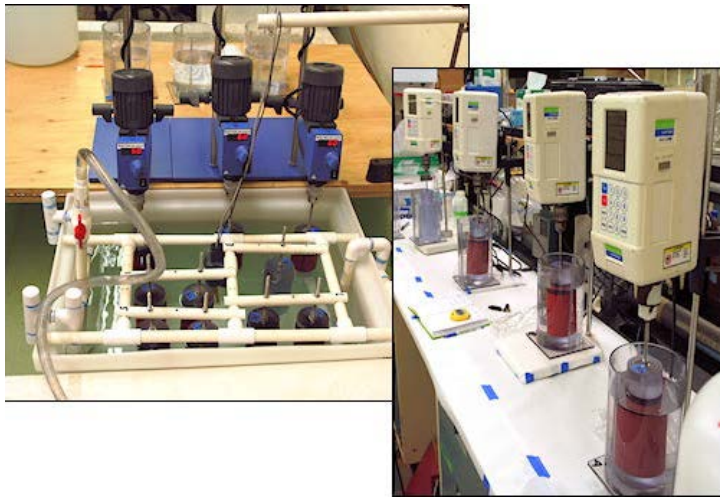
Lagerström, M., Yngsell, D., Eklund, B., Ytreberg, E. 2019. Identification of commercial and recreational vessels coated with banned organotin paint through screening of tin with portable XRF. Journal of Hazardous materials

Ytreberg, E., Lundgren, L., Bighiu, M.A., Eklund, B., 2015. New analytical application for metal determination in antifouling paints. Talanta 143, 121-126.

How to calculate the pressure of biocides from antifouling paints?

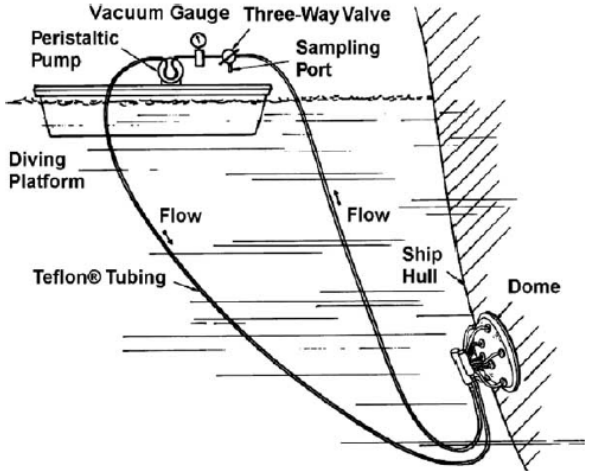
Rotating cylinder methods

- Standardized methods (ISO and ASTMO
- Time consuming
- Costly
- Do not reflect field conditions



DOME –method

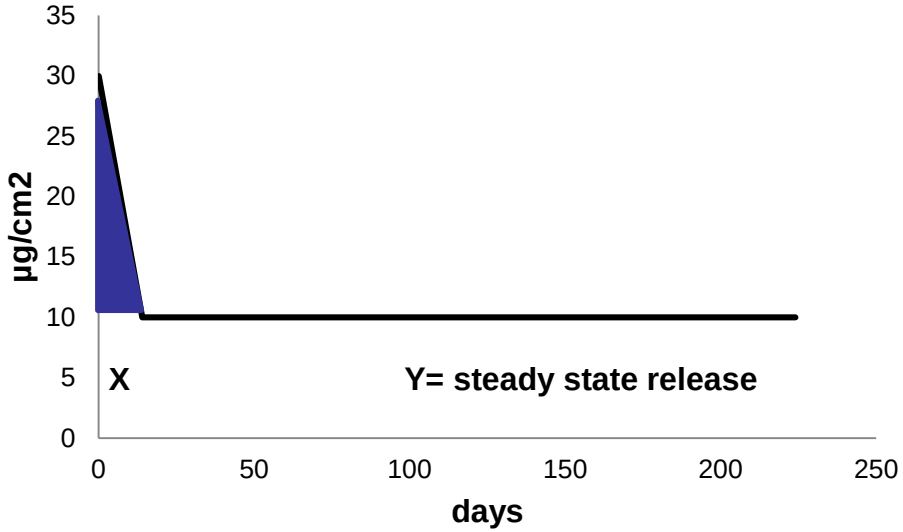
- In-situ method
- Most environmentally realistic method
- Involves divers - costly



Valkirs, A.O., Seligman, P.F., Haslbeck, E., Caso, J.S., 2003. Measurement of copper release rates from antifouling paint under laboratory and in situ conditions: implications for loading estimation to marine water bodies. Mar. Pollut. Bull. 46, 763–779.

CEPE –mass balance model

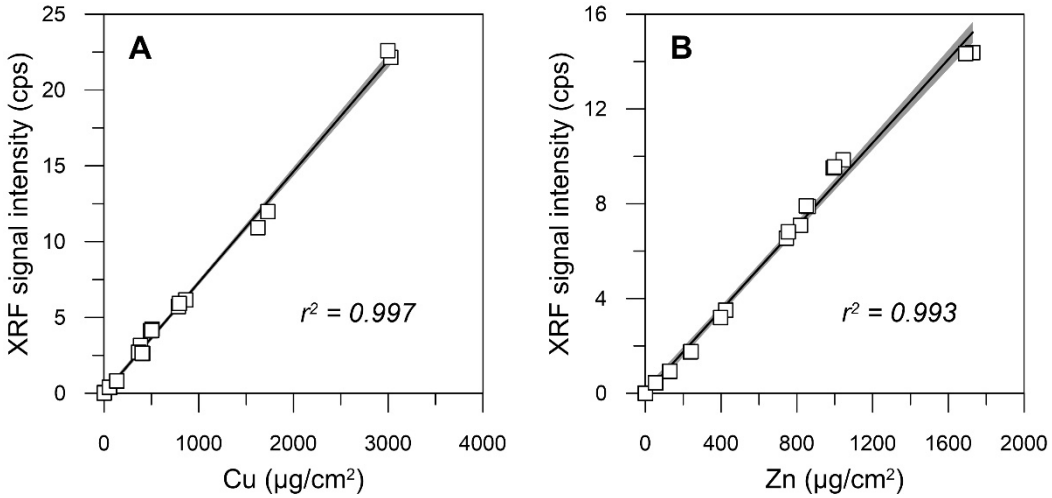
- Calculation method
- No cost
- Not fully validated
- Used in risk assessment in EU



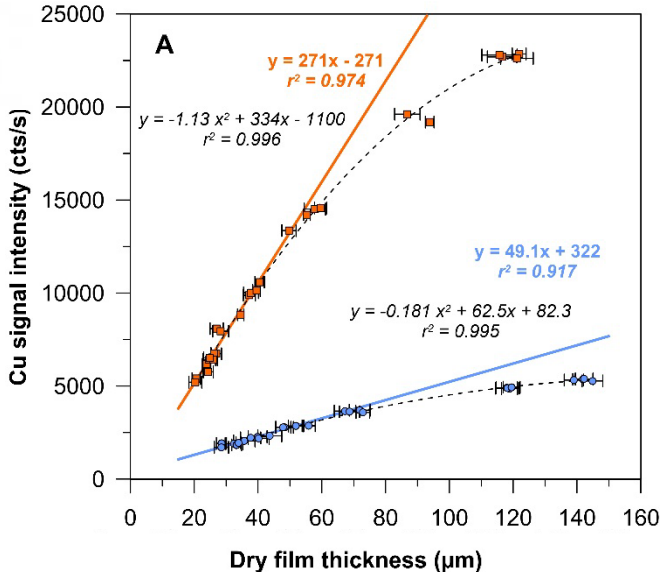
Y = overestimate release rate compared to the DOME method. Tier 2 allows to use a correction factor for marina (amateur use) scenarios, i.e. Y is divided by 2.9

Development of a new release rate method based on XRF

Calibration curve, Cu and Zn



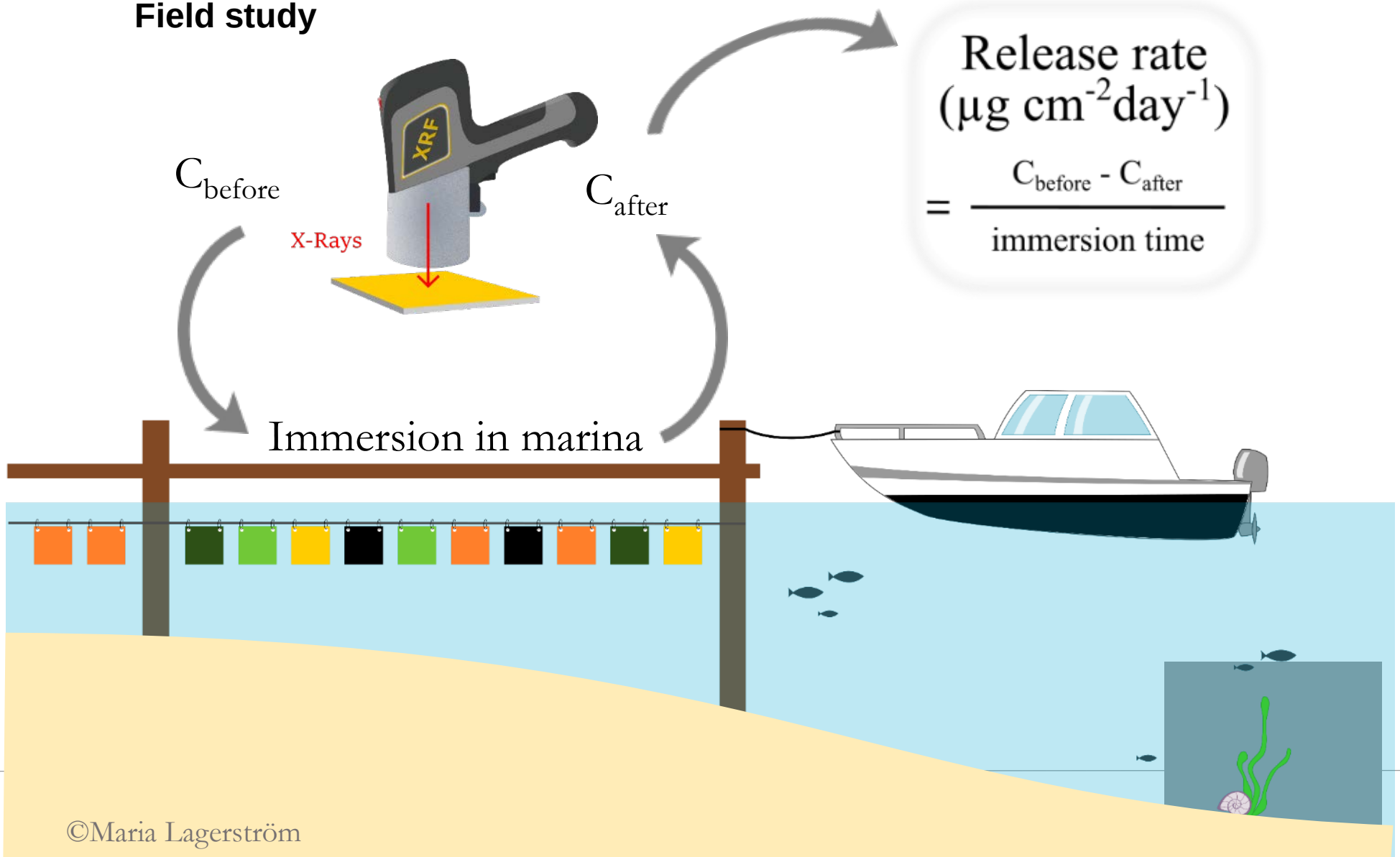
Effect of paint thickness on Cu signal intensity



- High Cu_2O conc paint (34%)
- Low Cu_2O Cu conc paint (7%)

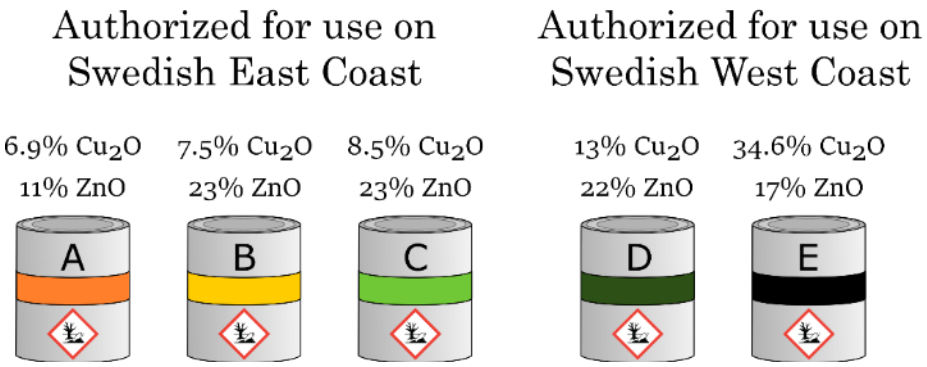
Ytreberg, E., M. Lagerstrom, A. Holmqvist, B. Eklund, H. Elwing, M. Dahlstrom, P. Dahl, and M. Dahlstrom. 2017. A novel XRF method to measure environmental release of copper and zinc from antifouling paints. Environmental Pollution **225**:490-496.

Field study



Field study 2015

- 5 AF paints



- 2 marinas (2 salinities)
- Up to 84 days of immersion

  (2/3 of the boating season)

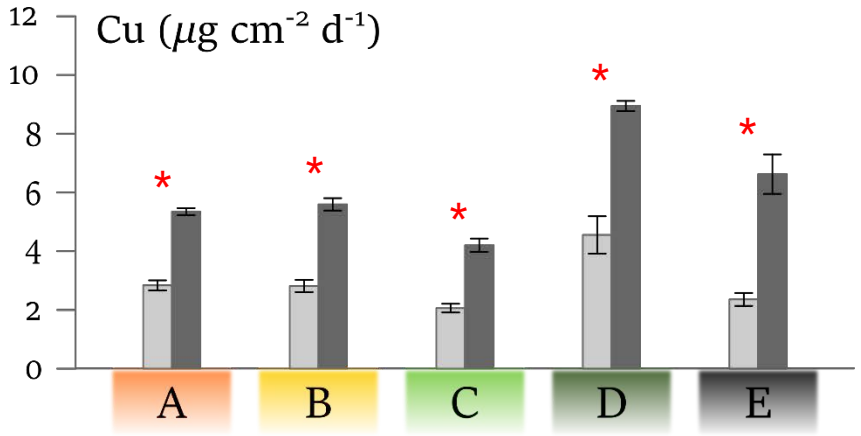
Fiskebäck Marina 14‰

Bullandö Marina 5‰

Aims: study the **effect of salinity** & **compare** in situ release rates with those used to gain product approval

Lagerström et al. 2018
"In situ release rates of Cu and Zn from commercial antifouling paints at different salinities"

Effect of salinity



Average release rate
over 84 days

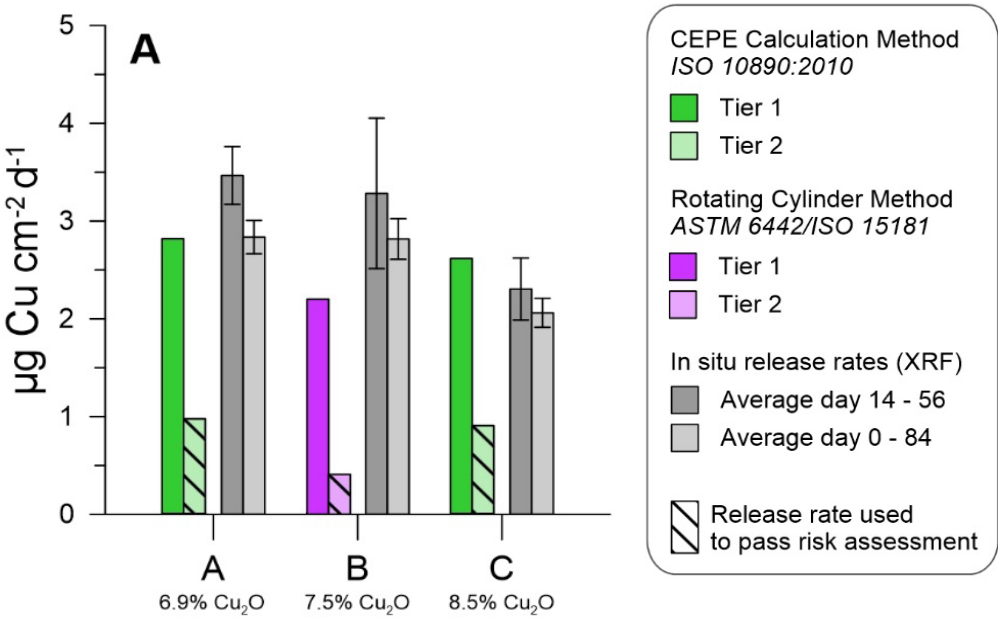
Salinity of 5‰

Salinity of 14‰

Cu x 2

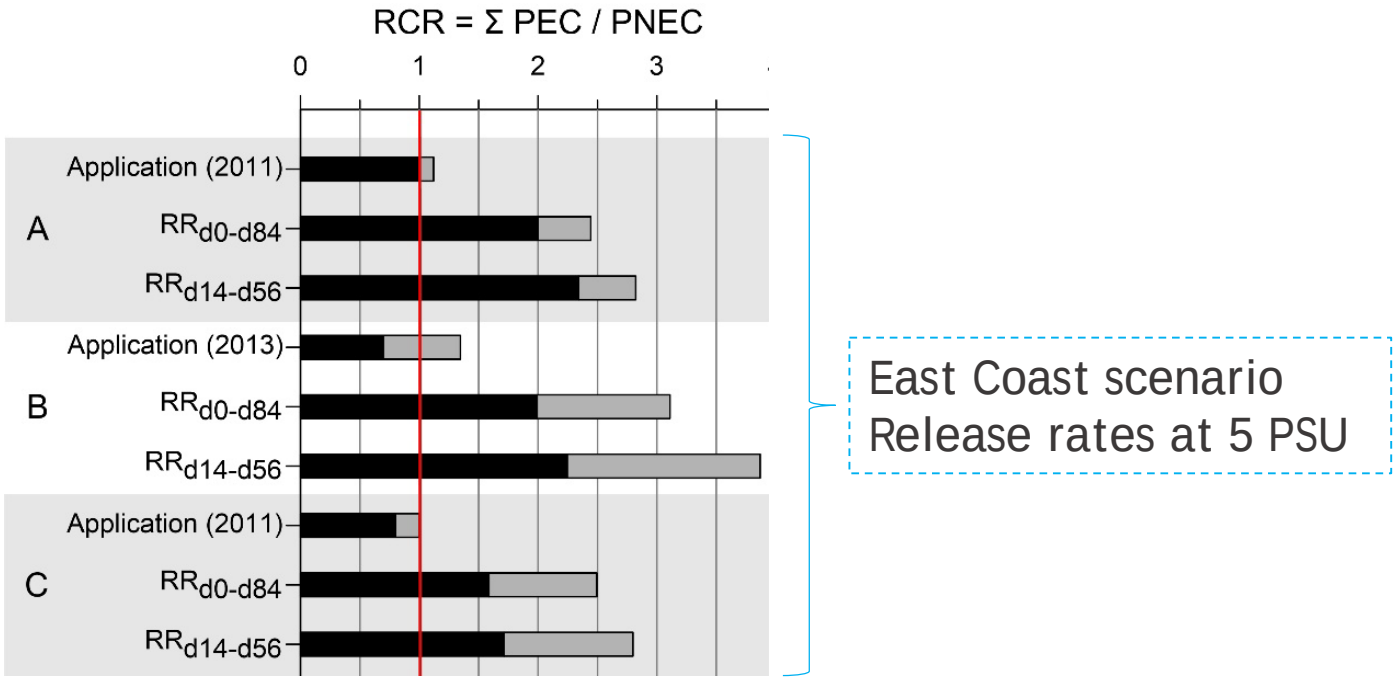
Comparison with standardized methods

5 PSU



- **Tier 2 release rates (used in risk assessment) underestimate the release rates**
  - **Cu: 3-8 times**

Risk assessment repeated



East Coast scenario
Release rates at 5 PSU

How is shipping and leisure boating affecting the status of the Baltic Sea (with respect to contaminants)

Pressure →

Emission factors + Activity data

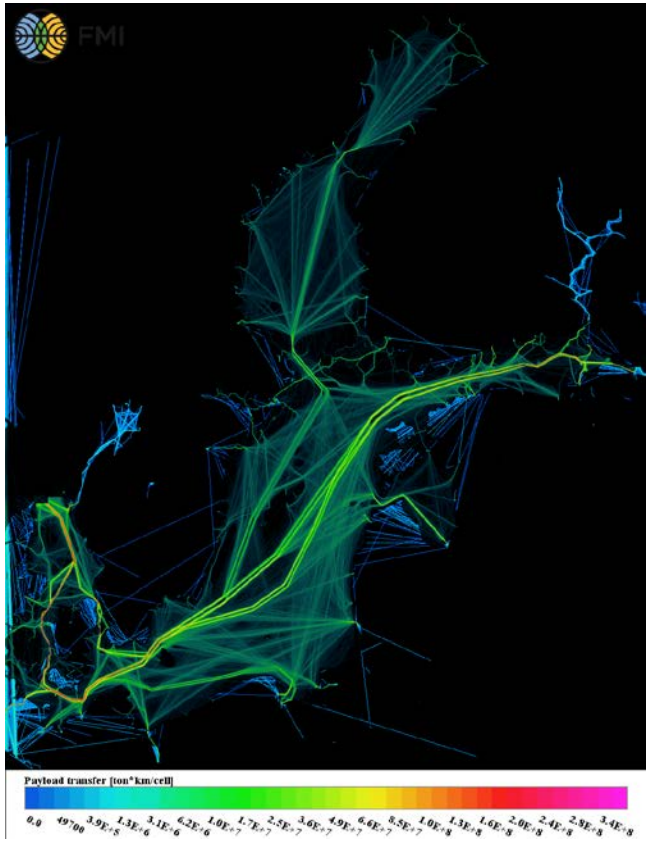
modelling

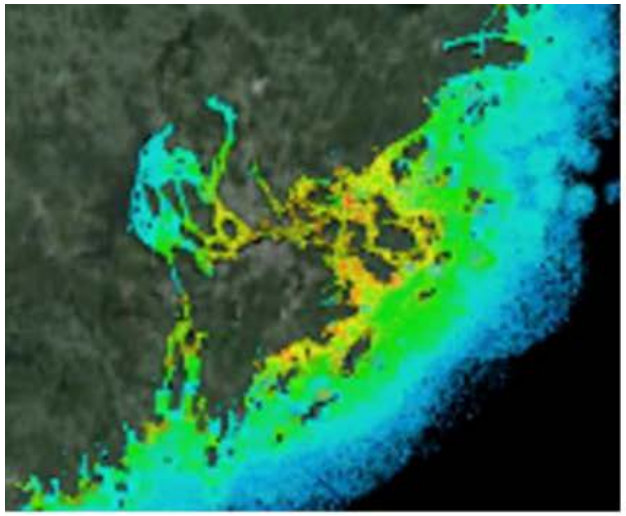
State →

PEC (predicted environmental concentration)
Effects on species

Impact →

Effects on ecosystem services and human well-beeing





Simulation of leisure boat activities and emissions at the Baltic Sea (SHEBA project)
Lasse Johansson, Jukka-Pekka Jalkanen[1], Erik Fridell[2] , Erik Ytreberg[4], Martin Eriksson[4] , Ilja Maljutenko[3], Maria Lagerström, Armin Aulinger[6], Vivian Fischer[6] and Eva Roth[5]

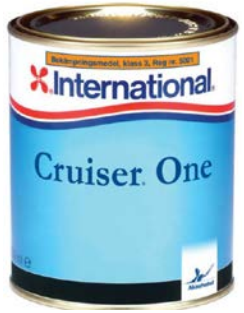
How is shipping and leisure boating affecting the status of the Baltic Sea (with respect to contaminants)

Waterborne copper input to the Baltic Sea

Country	Copper (tons)
Denmark	No available data
Estonia	110
Finland	128
Germany	8
Latvia	75
Lithuania	No available data
Poland	142
Russia	184
Sweden	239
Total	**886**

References: HELCOM, 2011. The Fifth Baltic Sea Pollution Load Compilation (PLC-5) Balt. Sea Environ. Proc. No. 128

Pressure



Antifouling	Copper (tons)
Shipping	302
Leisure boats	57
Total	**359**

Preliminary data from the EU BONUS project SHEBA, Sustainable sHipping and Environment of the BAltic Sea region

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How is shipping and leisure boating affecting the status of the Baltic Sea (with respect to contaminants)

State

39 coastal Swedish water bodies have been analyzed for Cu.

67% of them did not reach Good Ecological Status due to elevated Cu conc.

Conclusion

- Environmental risk assessment of AF coatings is based on inaccurate release rate predictions
- The ERA is not protecting the environment, i.e. we will have marinas holding elevated Cu concentration that poses a risk for the Baltic Sea environment
- May have impacts on the Status classification, water bodies will not reach Good Status

Thank you for listening!

- **Questions?**

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