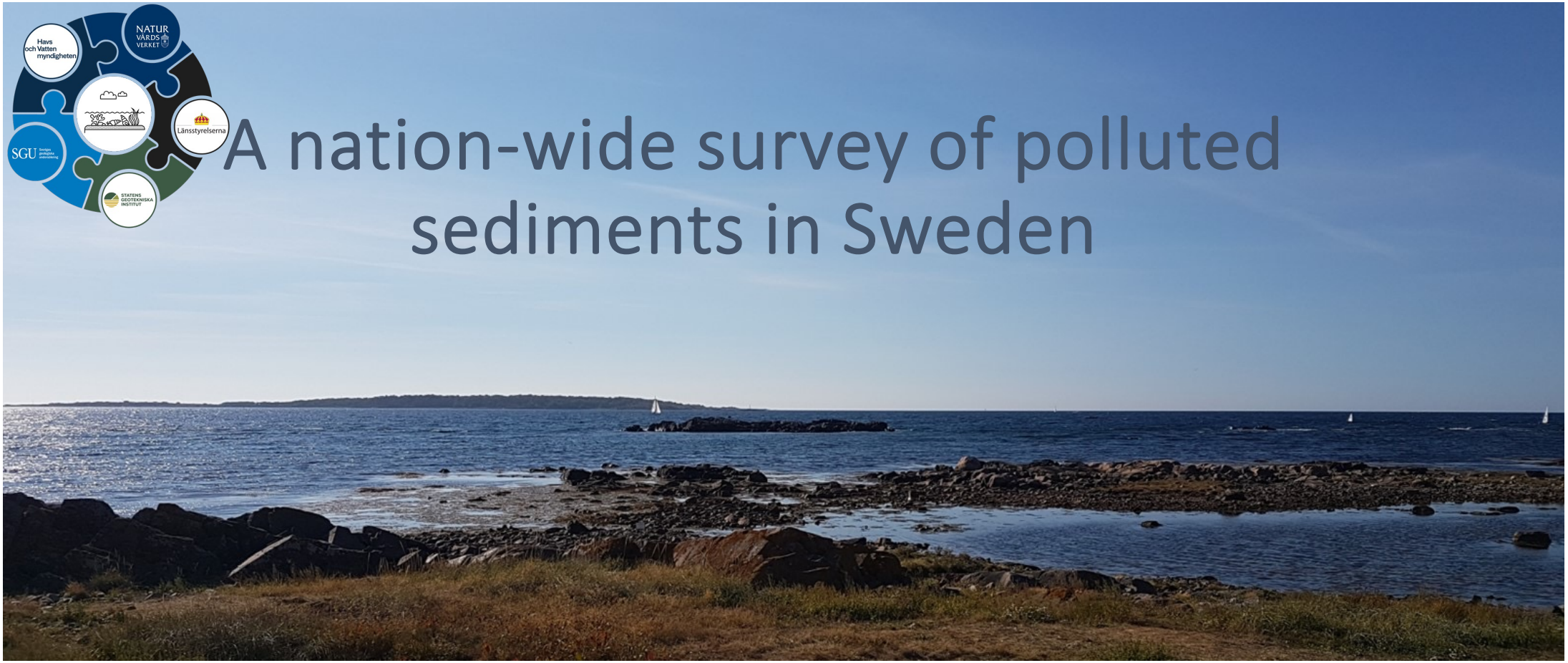

A nation-wide survey of polluted sediments in Sweden

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SedNet Conference 2023, Portugal

SGU Sveriges geologiska undersökning

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Agenda

- Background
- Aim with the survey
- Methods – selection of areas and fieldwork
- Results – examples and highlights
- Summary
- Reports

Background - The situation in Sweden

Long history of industrial activities, often concentrated near running waters and the coastline

- Forest industry/papermills, pulp fiber
- Manufacturing industry, steel industry, refineries etc.
- 20 000 firefighting drill sites
- Power plant dams
- Harbors and leisure boat harbors

Background - Surface water bodies in Sweden

Type of water	**Number**
Coastal water	654
Lakes	7 453
Running water	15 688
Sum (excl open sea water)	**23 795**

Background – Governmental assignment

- Remediation of contaminated areas in the last decades – focus on land areas
- Knowledge gaps on the situation in sediments
- Governmental assignment 2019 to 5 Swedish authorities:
  - to improve the knowledge on how to manage contaminated sediments
- Among the activities:
  - investigate sediments and develop guidelines

Aim of the field survey

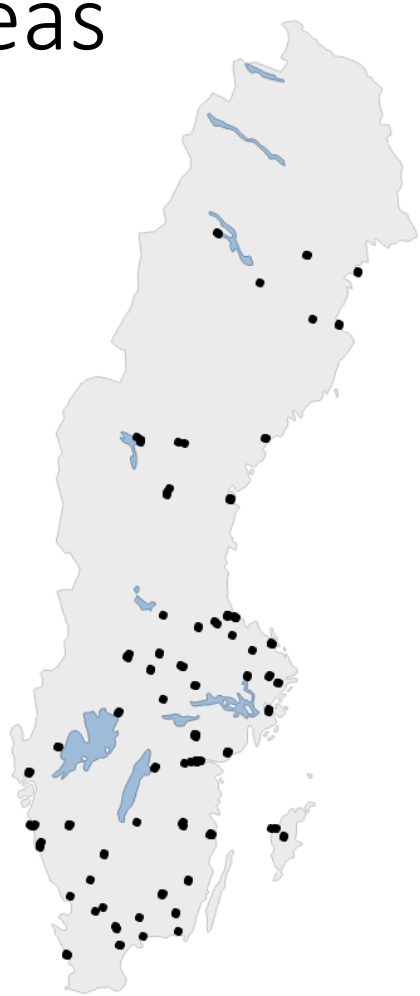
- Increase the knowledge about pollutants in sediments in Sweden, related to different types of:
  - recipients
  - impact sources

- Contribute to a:
  - national overview
  - knowledge basis for future inventory, risk classification and remedial work
  - further source tracking

Photo: SGU

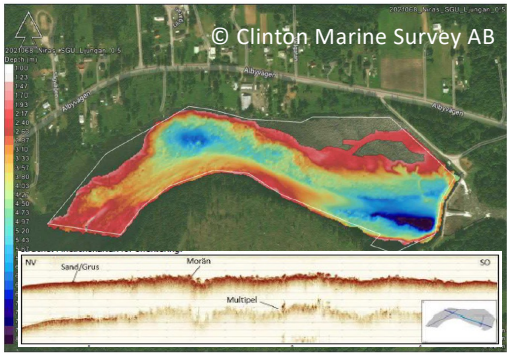
Field survey – Selection of survey areas

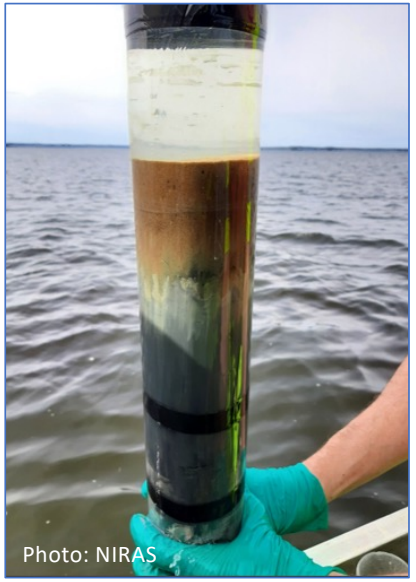
- Based on identification of significant pressures from point sources of pollution
  ⇒ **3000** surface waters
- Based on types of water and point sources
  ⇒ **340** surface waters
- Collaboration with County Administrative boards
  ⇒ **72** surface waters (32 lakes + 24 streams + 16 coastal areas)
- Evenly distributed (by number) in 21 counties



Field survey – Fieldwork and analysis

- Hydroacoustic measurements
  - Characterizing the bottom for sampling
    - Single-beam sonar (lakes & streams)
    - Multibeam sonar (coastal areas, fiber banks & dams)
- Sampling of sediment
  - Core sampler & box-corer
  - Surface (0-5 cm) & deeper (15-20 cm) sediment layers
  - >300 samples
- Analysis
  - Chemical analysis
    - “Basic package” of physical & chemical
    - Additional substances depending on point source industries
    - >300 substances
  - Toxicity test
    - CALUX®
    - Cellular response to dioxins, PAH and estrogen-like substances

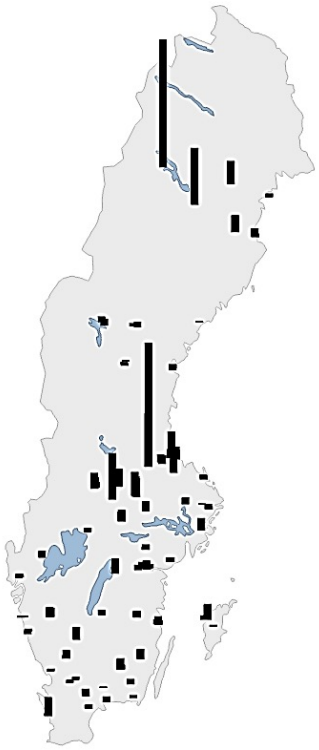




Results – commonly measured substances

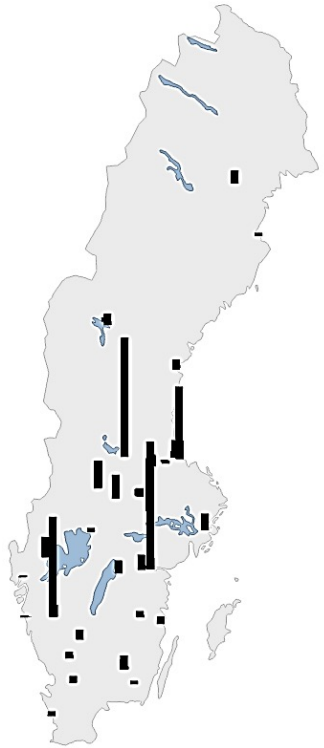
Metals

- ∑ Cd, Hg, Ni, Pb, As, Cr, Cu, U & Zn
- 80 – 10,000 mg/kg (dw)
- Highest concentrations
  - Mines
  - Steel industries



Dioxins (PCDD/F)

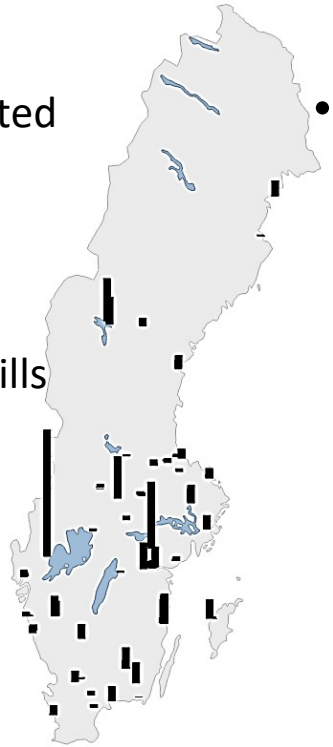
- Additional analysis based on pressure
- 0,04 – 14 µg/kg (dw)
- Highest concentrations
  - Pulp & paper industries
  - Textile industries
  - Steel industries



Results – rarely measured substances

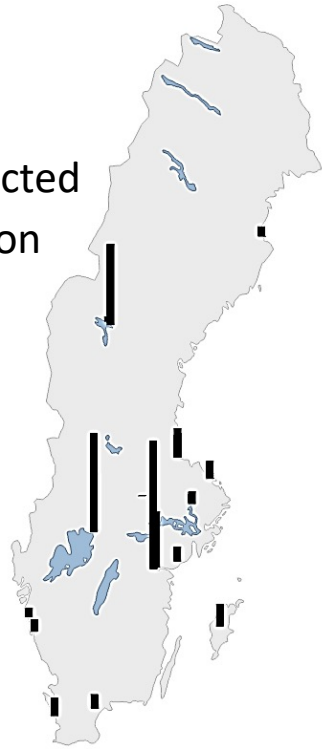
$PFAS_{35}$

- Additional analysis based on pressure
- 0,053 – 22 µg/kg (dw)
  - PFOS most frequently detected
  - PFBS highest concentration
- Highest concentration
  - Pulp & paper industries
  - Waste management & landfills
  - Fire fighting



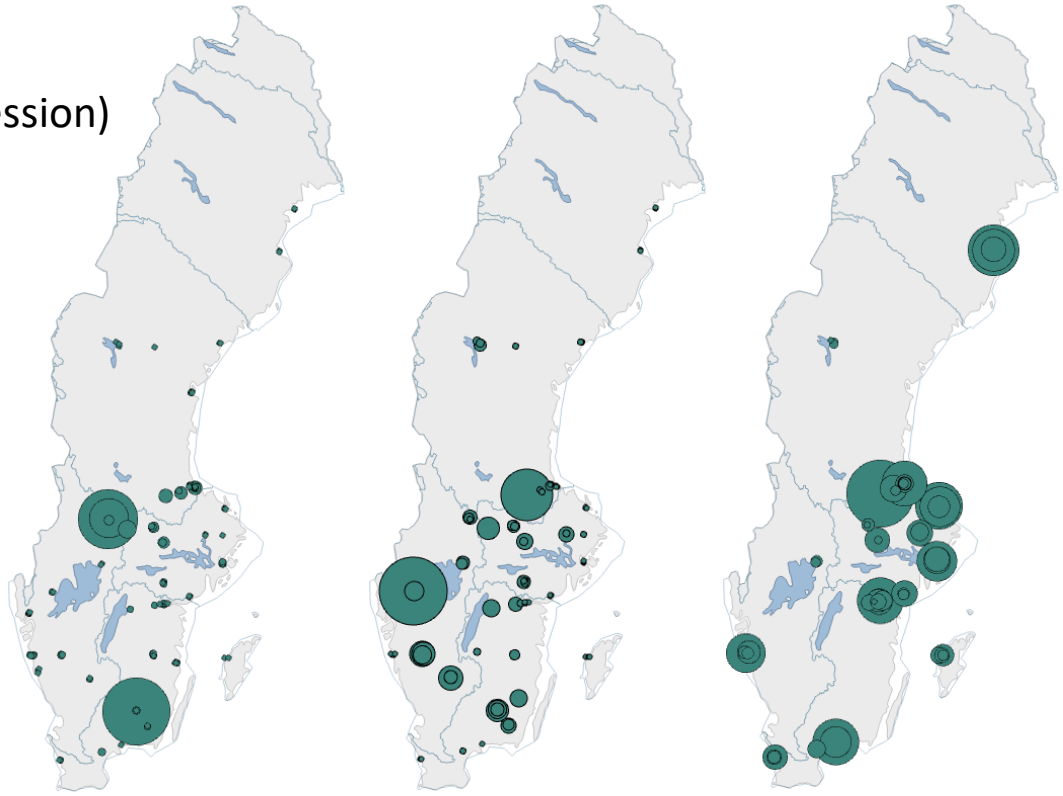
Pharmaceuticals

- Additional analysis in WWTP recipients
  - 40 pharmaceuticals
- 0,18 – 89 µg/kg (dw)
  - Citalopram most frequently detected
  - Paracetamol highest concentration



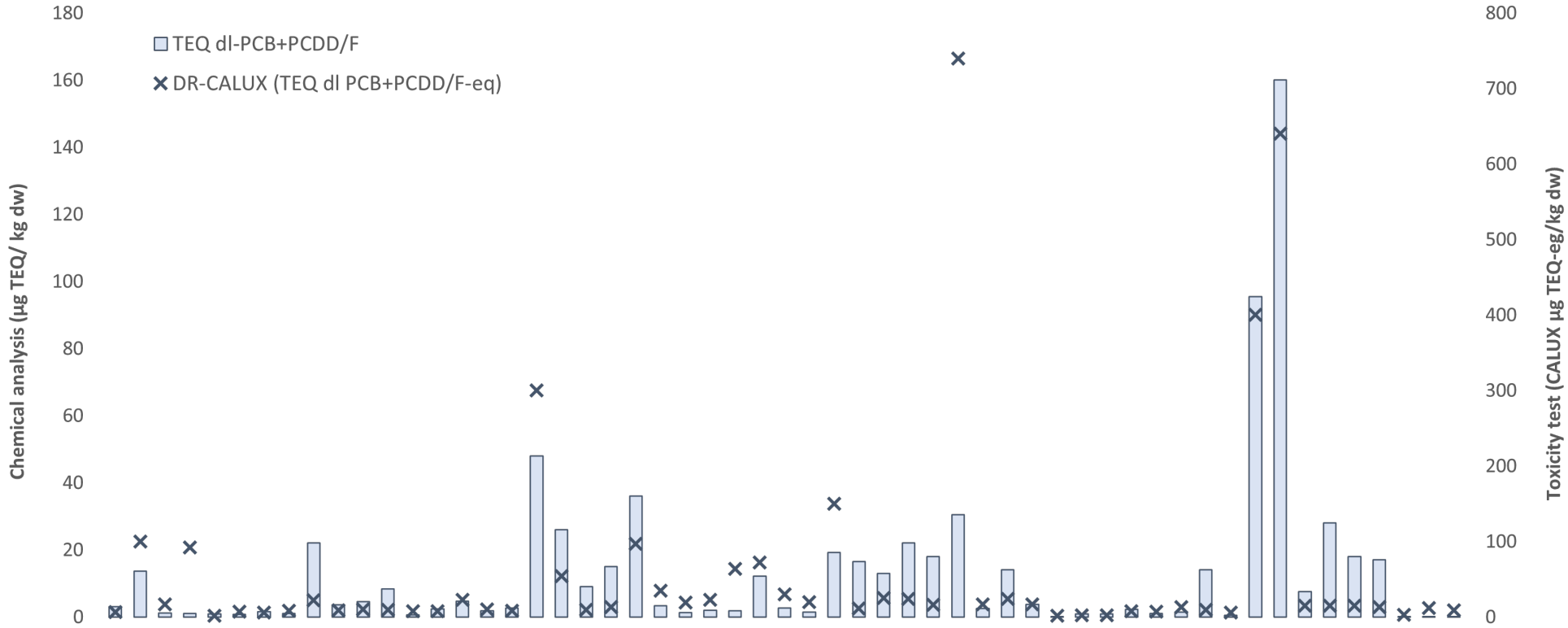
Results – Toxicity tests

- CALUX®
  - Chemical Activated LUciferase gene eXpression)
  - Cell-based *in vitro*-test
- Responses to different substances
  - Dioxins: DR-CALUX
  - PAH: PAH-CALUX
  - Estrogens: ER-CALUX



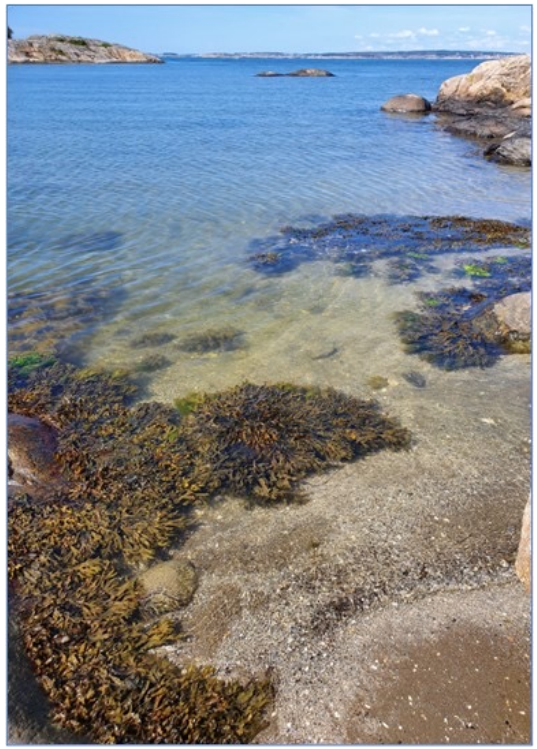
DR-CALUX PAH-CALUX ER-CALUX

Results – Toxicity test *vs* chemical analysis



Summary – Field survey

- Overview of contaminants in sediment and knowledge about methodology and choice of parameters
- Hydroacoustic measurements are essential to understand the conditions at each location
- Site specific high levels of historical contaminants such as metals and dioxins, and widespread occurrence of PFAS and pharmaceuticals
- Toxicity tests can be a useful complement to chemical analysis to interpret the effects on biota of the total load of contaminants

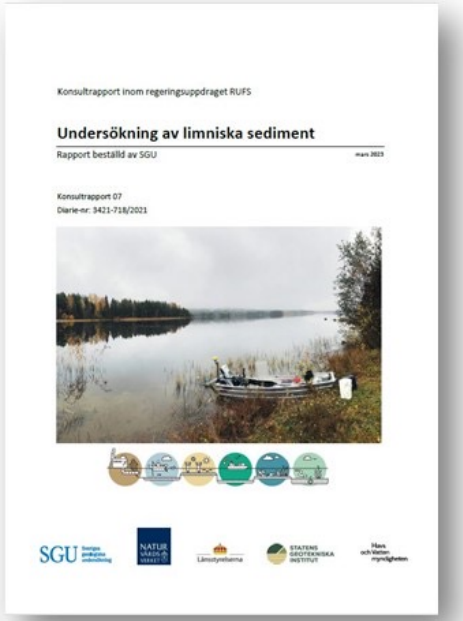


Published reports – Field investigations

Field reports available at renasediment.se (in Swedish with summary in English):

Coastal areas

Lakes and rivers



Lake Vänern

A summary report

Additional reports – PFAS and screening

Sediment was collected to contribute to 2 other studies:

- Screening of **per- and polyfluoroalkyl substances** (PFAS) in sediment and water close to paper industries
- **Non-target screening** of emerging contaminants and their transformation products in marine biota and sediment samples from the Baltic Sea

Reports available at renasediment.se

Acknowledgements to:

NIRAS Clinton

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