

New Approaches in Determining the Impacts of Chemical Pollution to Protect the Biodiversity of the Baltic Sea

Detect2Protect

Newsletter No. 2



THE MISSION

Detect2Protect (*New approaches in determining the impacts of chemical pollution to protect the biodiversity of the Baltic Sea*) examines the relationships between chemical pollution and biodiversity in the Baltic Sea. Apart from gaining important new knowledge on this linkage the objective is to develop integrated chemical-biological monitoring and assessment frameworks for the marine environment.

PARTNERS OF THE PROJECT



- Marine and Freshwater Solutions, Finnish Environment Institute, Helsinki, Finland (Syke)
- Department of Marine Systems, Tallinn University of Technology, Tallinn, Estonia (TalTech)
- Laboratory of Ecotoxicology, Nature Research Centre, Vilnius, Lithuania (NRC)
- Institute of Oceanology, Polish Academy of Sciences, Sopot, Poland (IO PAN)
- Marine Monitoring, Latvian Institute of Aquatic Ecology, Agency of Daugavpils University, Riga, Latvia (LHEI)
- Department of Biological and Environmental Sciences, University of Gothenburg, Gothenburg, Sweden (BIOENV)
- Environmental Science, Stockholm University, Stockholm, Sweden (SU)
- Department of Life and Environmental Sciences, Università Politecnica Delle Marche, Ancona, Italy (UNIVPM) - subcontractor

www.biodiversa.eu/2023/04/19/detect2protect/

DESCRIPTION AND KEY OUTPUTS OF WORK PACKAGES (WP)

WP 1



Project management

Syke is responsible for all operational management activities of the project, including the organising of meetings and workshops, monitoring and administration. Syke together with the WP leaders ensures that the work in all WPs is performed according to the agreed work plan and a timely production of project outputs.

WP 2



Data mining

Open source databases are used to collect data on (i) chemical contaminants in sediment and biota, (ii) biological effect parameters in target species, and (iii) species abundance in benthic communities aggregated into a structured data set.

- Impact map for sampling site selection
- Background data for integrated assessments

WP 3

Field studies and laboratory analyses



Target species were collected from six study regions to assess their contaminant levels and health status by using various biological effects methods. These data will be linked to eDNA metabarcoding for community diversity analysis and stable isotope mapping of the trophic niche.

- Review on the use of biological effects methods in the Baltic Sea
- Report on biomarker baseline variability in the study regions
- Report on the synthesis of biological effects and biodiversity in contaminated vs. reference sites
- A complete project dataset
- Scientific publications

WP 4



Data integration, multivariate analyses and modelling

The data obtained in WP2 and WP3 will be processed in WP4 to investigate relationships between the different contamination and biological effect patterns with biodiversity.

- Data integration procedures and new approaches
- Multivariate analysis on linkages between biodiversity and contamination
- Structure of the diagnostic model and first results from its application

WP 5

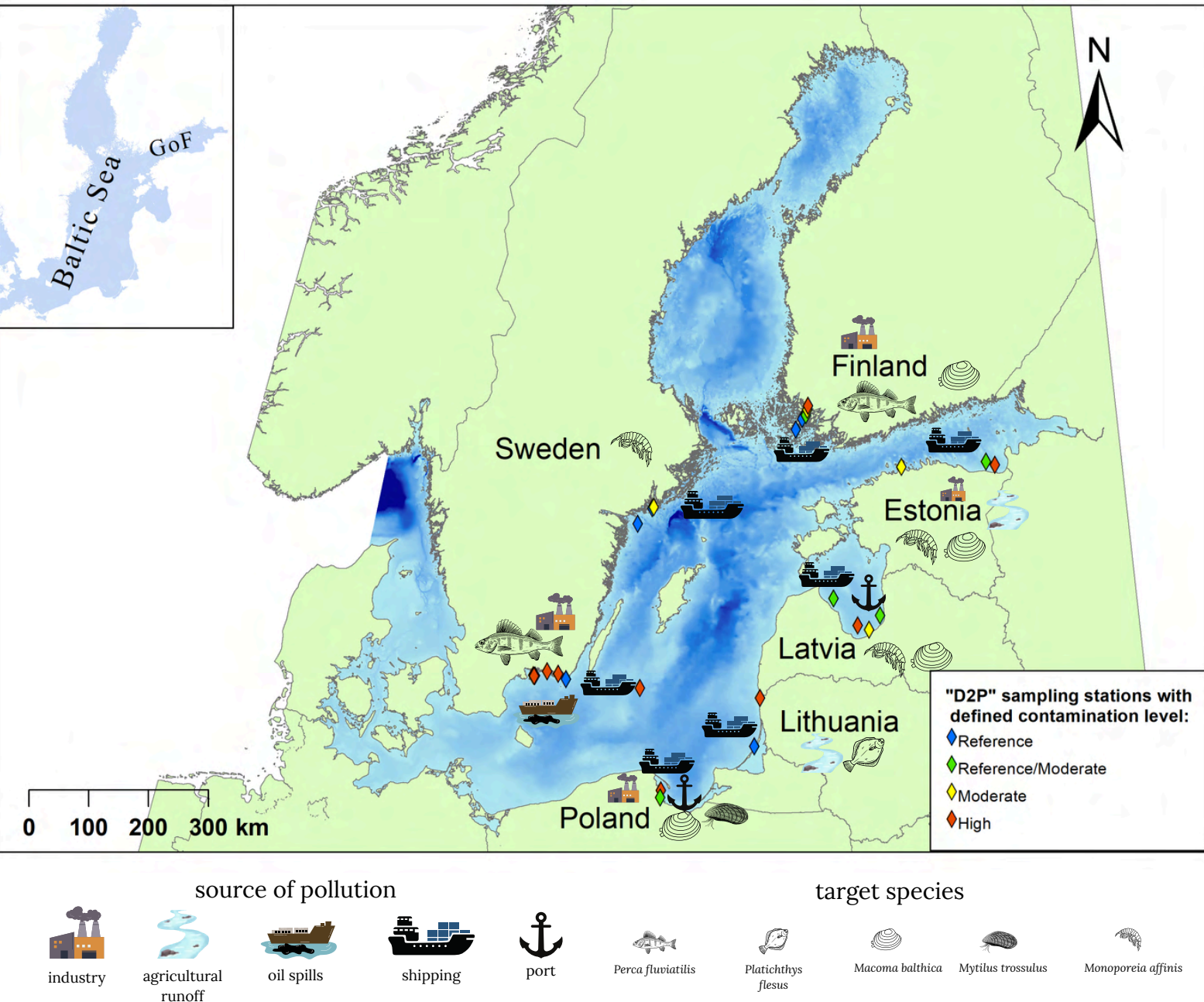


Dissemination of results and stakeholder involvement

Outreach activities, dissemination of results, and communication with stakeholders are channelled via WP5 in collaboration with WP1. The results will be systematically presented to researchers, policy makers and the general public.

- Project website and periodic newsletters
- Stakeholder workshop
- Policy Brief

LOCATIONS OF SAMPLING SITES



Extensive chemical pollution originating from both terrestrial and marine sources affects the Baltic Sea. The majority of sources are land-based, including runoff from farms and industries, wastewater treatment facilities and atmospheric deposition of industrial pollutants. Shipping, fishing, and past marine dumpings such as World War II chemical munitions are examples of marine sources.

TARGET SPECIES

In the selection of target species we considered several key features including ecological relevance, sensitivity to contaminants, response time to environmental stressors and the possibility to measure biological effects using biomarkers.

Due to its low biodiversity the Baltic Sea offers a limited number of potential target species suitable for biological effect monitoring. The newly updated recommendations of the ICES/OSPAR/HELCOM Study Group SGEFF include several fish, bivalve, amphipod and gastropod species. In Detect2Protect, the following were chosen: the European perch *Perca fluviatilis* and European flounder *Platichthys flesus* for fish, the Baltic clam *Macoma balthica* and the mussel *Mytilus trossulus* for bivalves, and *Monoporeia affinis* for crustaceans. However, not all of them could be studied at all the study regions.



Mytilus trossulus



Macoma balthica



Monoporeia affinis



Perca fluviatilis

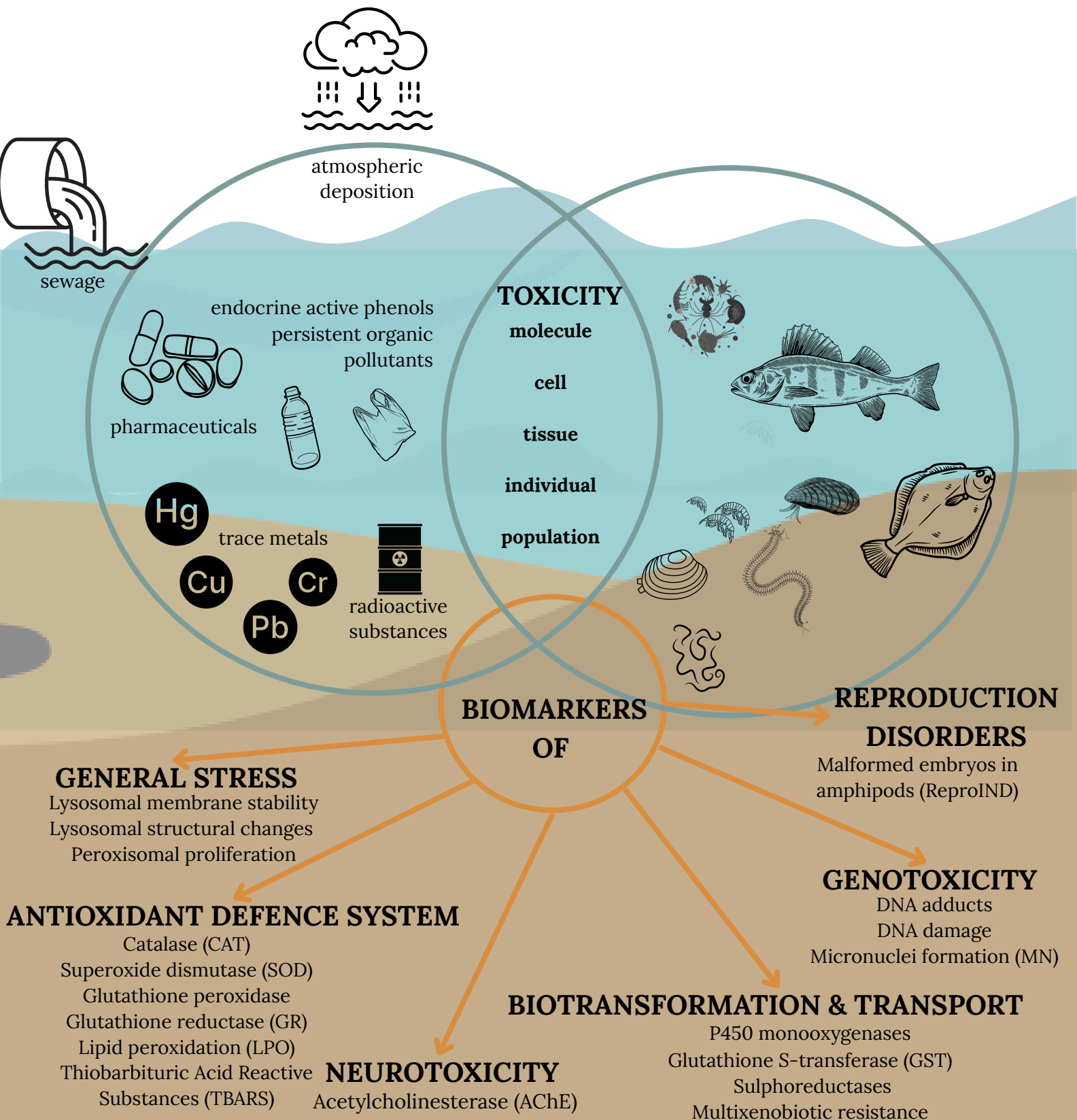


Platichthys flesus

GENERAL APPROACH

CHEMICAL ASSESSMENT

BIOLOGICAL ASSESSMENT



SELECTED METHODS

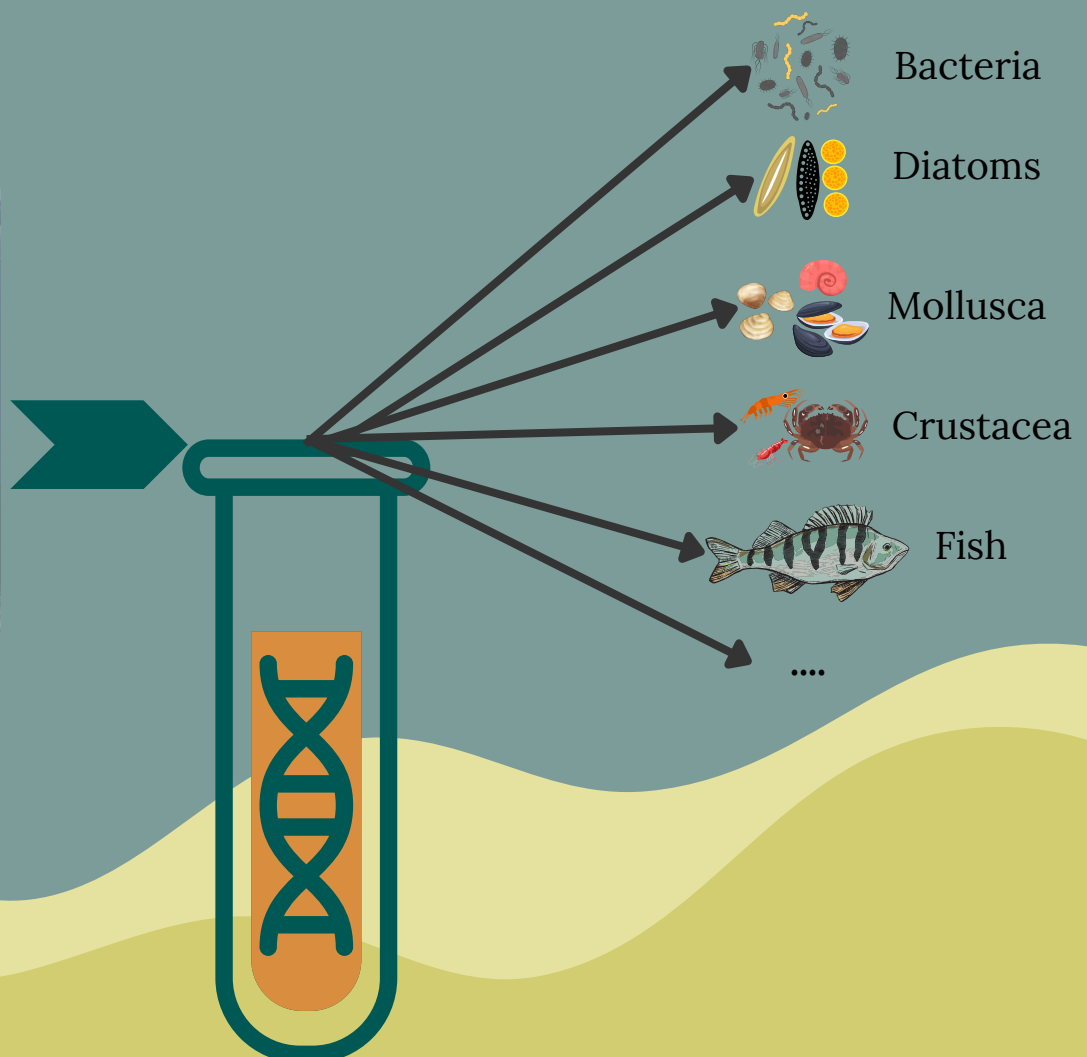
Metabarcoding using environmental DNA (eDNA) is a promising tool for biodiversity assessment. Sequencing of DNA from environmental samples is used to determine the presence of species and to assess overall biodiversity. To study the impacts of pollution on biodiversity we combined the eDNA approach with biological effects methods (biomarkers) and chemical data to integrate responses across the different levels of biological organisation.

COLLECTION OF SEDIMENT SAMPLES



eDNA METABARCODING

INFORMATION ON LOCAL BIODIVERSITY



SELECTED METHODS

The chosen biological effect methods focus on some key types of chemical toxicity with potential impacts at population, community and ecosystem levels.

**Micronucleus test
and other nuclear
abnormalities;
enzyme activities of
CAT, SOD and GST;
blood glucose**

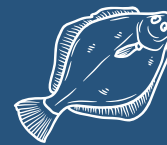


Benthic amphipods

AChE, TBARS, CAT, GST, GR



European perch



European
flounder

**AChE, CAT, GR, GST, TBARS,
ReproIND**



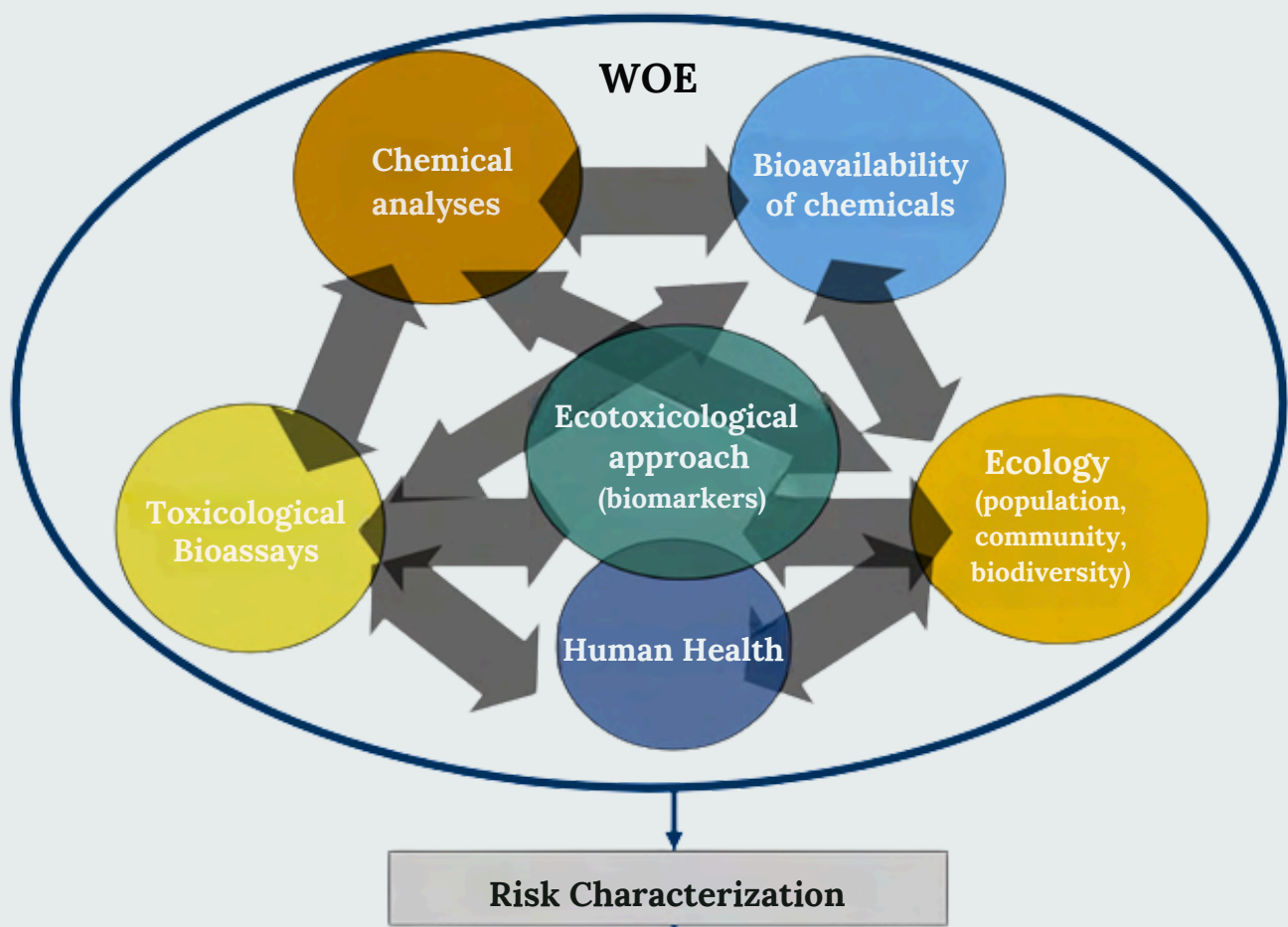
Baltic clam



Blue mussel

DATA INTEGRATION

The obtained data will be processed in WP4 to investigate relationships between the different contamination and biological effect patterns as well as their relationships with the observed biodiversity at the polluted and unpolluted study sites in each region. Several approaches will be used, including integrative biomarker index calculation methods and the weight-of-evidence approach (WoE) consisting of the integration of different typologies of environmental parameters.




LATEST ACTIVITIES



We actively participated in the Baltic Sea Science Congress 2025, showcasing our recent work via several oral presentations and posters. Furthermore, the use of biomarkers in the monitoring of the Baltic Sea environment was addressed in the side event “Monitoring of Chemical Pollution in the Baltic Sea: Why and How Biological Effects Measurements Fit in?”, co-organised by the project.

<https://www.bssc2025.pl>




Impacts of chemical pollution on biodiversity and biological responses in the Archipelago Sea (Baltic Sea)

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Abstract: Chemical pollution is a major threat to marine ecosystems. This study combines biochemical biomarkers in the soft-bottom clam *Macoma balthica* with benthic community metrics to reveal how contaminants impact marine biodiversity. Biomarkers provide early warning signals of sublethal stress that may precede visible changes in community structure.

Results & Discussion

- Site 1:** Unpolluted, stable temperature, reference station
 - Biomarkers showed no significant physiological stress in *M. balthica*.
 - Highest abundance and species richness in benthic fauna.
 - Dominance of pollution-sensitive amphipods (*M. affinis*, *P. pinnatus*) explained low diversity and evenness despite high species richness.
- Site 4:** Polluted, stable temperature
 - Biomarker responses indicate oxidative damage and weakened antioxidant defense, also low abundance of *M. balthica* was observed.
 - Moderate diversity and evenness, but reduced species richness.
 - Mix of pollution-sensitive (e.g., *H. spinulosus*, *M. affinis*) and tolerant species (e.g., *Marisa zelandica* spp.), indicating a transitional community under moderate stress.
 - Low *M. balthica* performance and stress biomarkers, along with reduced richness and a mix of sensitive and tolerant species, indicate chronic pollution impact and a community in ecological transition.
- Site 5:** Unpolluted, affected by a heatwave
 - M. balthica* showed high abundance and biomass, suggesting a healthy population undergoing active growth and reproduction.
 - Cellular stress likely caused by the heatwave, resulting in increased membrane damage (elevated LPO) and DNA damage, as evidenced by an elevated genotoxic and cytotoxic response (increased MN frequency).
 - Benthic macrofauna community showed high diversity and evenness, but low total abundance.
- Site 6:** Polluted, affected by a heatwave
 - M. balthica* showed an elevated antioxidant defense system response via elevated SOD and a low Cl, reflecting the high energetic cost of sustained physiological stress. Low abundance and biomass of *M. balthica* suggest possible demographic/genetic erosion or reproductive failure.
 - The lowest biodiversity among the sites; community dominated by pollution-tolerant taxa, indicating a severely disturbed benthic ecosystem.
 - Combined stress of chronic pollution and the heatwave results in an ecologically degraded community.
 - In *M. balthica*, the depleted energy reserves (low Cl) likely limit biomarker response capabilities, thus masking acute stress effects.



Methods

- M. balthica* and sediment were collected in the Archipelago Sea (SW Finland) in August 2024 along an assumed contamination gradient.
- Biomarkers measured in *M. balthica*: Mitochondrial and nuclear buds (MN) for cytotoxicity and genotoxicity; lipid peroxidation (LPO), superoxide dismutase (SOD), catalase (CAT), glutathione S-transferase (GST), glutathione peroxidase (GPx) for oxidative stress; acetylcholinesterase (AChE) for neurotoxicity; and benzo(a)pyrene (B[a]P) for genotoxicity.
- The benthic macroinvertebrate community was analyzed for abundance and biomass. Biodiversity was assessed by using species richness, Shannon diversity (H'), and Pielou's evenness (E).

Fig. 1. Community composition of benthic Fig. 2. Benthic macrofauna community macrobenthos data to total biomass proportions, directly expressed on Shannon diversity. Total species abundance per site (mean ± SEM) Pielou's evenness and species richness is given on the right (only light grey).

Table 1. Summary of study site conditions, *M. balthica* abundance and biomass, biomarker responses, and the Integrated Biomarker Response (IBR) calculated from the individual biomarkers. Symbols: ↑ increased value, ↓ decreased value, = no notable change compared to reference (site 1).

Site	Temp	Depth	Contamination	Abundance	Biomass	IBR	SOD	GPx	AChE	LPO	CAT	GST	MN	Cl
REF. 1	15.1	10	Low	High	High	0.0	+	+	+	+	+	+	+	+
REF. 2	15.1	10	Medium	High	High	0.0	+	+	+	+	+	+	+	+
REF. 3	15.1	10	High	High	High	0.0	+	+	+	+	+	+	+	+
REF. 4	15.1	10	Low	Low	Low	0.0	+	+	+	+	+	+	+	+
REF. 5	15.1	10	High	High	High	0.0	+	+	+	+	+	+	+	+

A regional Detect2Protect study on the biological effects of chemical pollution with linkages to biodiversity was presented at the Society of Environmental Toxicology and Chemistry Europe (SETAC) Annual Meeting in Vienna (Austria) in May 2025.



<https://www.setac.org/discover-events/global-meetings/setac-europe-35th-annual-meeting.html>

LATEST ACTIVITIES

The Final “Save The Baltic Sea” Expedition Event in Lithuania

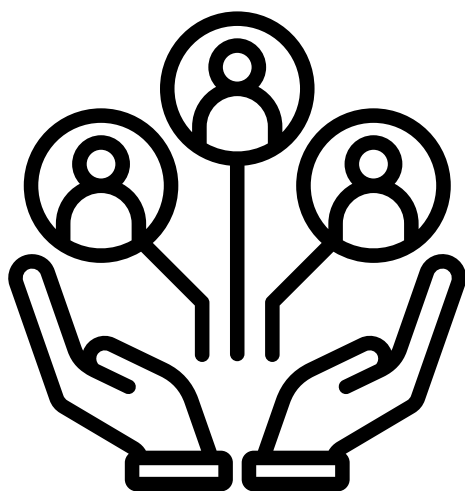
At the concluding event, Detect2Protect partner NRC presented the project’s goals and practical research, capturing the attention of both the public and media. Attendees also enjoyed the stunning wildlife photography of Baltic Sea biodiversity, captured by Dr. Justas Dainys, a project team member.

<https://gamtostyrimai.lt/en/save-the-baltic-sea-research-education-and-solutions-for-sustainable-future/>



First meeting with the Advisory Board (AB)

On March 20, 2025, the Detect2Protect project partners had their first meeting with the representatives of the AB assigned to the project. During the meeting the project coordinator presented an overview of the project, outlining its main objectives, scope, and expected impact. The WP leaders then provided a structured update on the progress, challenges and the planned next steps in each WP. The next meeting with the AB will be held in autumn 2025.



LATEST ACTIVITIES



Project meeting in Sopot, Poland on 30-31 May 2025

Implementation and the current status of the project was discussed in a meeting hosted by IOPAN. WP leaders presented the future plans and gave a summary of the work completed thus far. Over 20 researchers attended the assembly on-site or on-line, representing all the Detect2Protect partner institutions.

Welcome to the project new website!



<https://www.syke.fi/en/projects/detect2protect#wp5-%E2%80%93-dissemination-of-results-and-stakeholder-involvement->



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