

FINMARI Researcher Days 2026



Harmonizing Marine Data: EMODnet Geology, Seabed Substrate Work and the Related National Project MERTINET

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Organizations: Geological survey of Finland GTK, Finnish Environment Institute SYKE

- ✓ EMODnet Geology provides harmonized marine geological data across Europe and Caribbean seas for diverse needs of the societies
- ✓ Multiscale seabed-substrate maps and complementary datasets provide essential environmental insight
- ✓ MERTINET strengthens Finland's marine data coordination and flow of marine data





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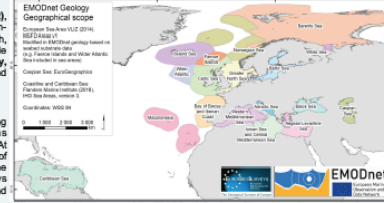
Kihlman, S.¹, Kaskela, A.M.¹, Kotilainen, A.T.¹, Wasiljeff, J.¹, Karvinen, V.², Seppälä, J.², & EMODnet – Geology Consortium
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Introduction

The European Marine Observation and Data Network (EMODnet), funded by the European Commission since 2009, provides high-quality *in situ* marine data from across Europe to support research, policy-making, and sustainable resource management. Accessible through EMODnet Portal, the project covers themes such as geology, bathymetry, biology, chemistry, human activities, physics, and seabed habitats.

EMODnet Geology

EMODnet Geology brings together marine geological data providing full coverage of European seas and has expanded to new areas including currently the Caspian Sea and the Caribbean Sea. At present, the project is coordinated by the Geological Survey of Finland GTK and executed by a consortium of 39 organizations. The core of the partnership is formed by members of the EuroGeoSurveys network, supported by other organizations with valuable expertise and data. The project promotes international cooperation between surveys and creates easily accessible uniform datasets for different stakeholders, such as researchers, decision-makers and the public. Users of the EMODnet Portal have the ability to view and download geological data through interactive maps and tools, which improves understanding of seabed geology and supports sustainable marine area management.



EMODnet Geology data products


- Seabed substrate (surface sediment), Sedimentation on rates and Seabed erosion/index
- Sea-floor geology – lithology and age bedrock geology beneath the surficial sediment: Quaternary units and pre-Quaternary, Geomorphological features of the sea-floor
- Coastal behavior (migration, type and vulnerability)
- Geological events and probabilities (e.g. submarine landslides, volcanic centres, earthquakes)
- Mineral occurrences (e.g. oil and gas, aggregates, metallic minerals)
- Submerged landscapes (e.g. submerged landforms and springs, paleosecessions, sea level index points)

In addition, the EMODnet Ingestion initiative is reaching out to potential data providers from the public and private sector and aims to improve the availability and usability of marine data by facilitating and enhancing the flow and collection process of data, in accordance with the FAIR principles.

All EMODnet Geology data available at EMODnet Portal
<https://emodnet.ec.europa.eu/en>

EMODnet Seabed substrate

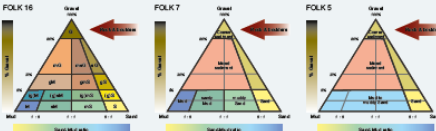
Seabed substrates and their characteristics, such as sedimentation rates, seabed erosion and other complementary information are among the key deliverables of the thematic. These datasets are crucial for applications including habitat mapping, resource management, and environmental monitoring. For instance, the Multiscale Seabed Substrate, using a modified Folk classification system harmonized from national data by sediment grain size, has been used to produce a seabed habitat map for the European marine areas. Additionally, the seabed substrate database includes information on seabed surface characteristics significant to the marine environment but not solely defined by grain size (e.g., seagrass meadows, moving sediments, ferromanganese concretions/bottoms, and bioclastic features).



FOLK 5

1. Mud to muddy Sand
2. Sand
3. Coarse substrate
4. Mixed sediment
5. Rock & boulders

EMODnet Seabed substrate data coverage (all scales included, September 2023)



Currently seabed substrate data products at different scales are: 1:1 000 000, 1:250 000, 1:100 000 and as a multiscale product including detailed data (1:1 500 to 1:70 000). The broad scale data describes the seabed substrate at a general level e.g. for visualisation, more detailed scale data (1:100 000 or finer) are needed for planning local constructions like wind farms, dredging and dumping or for habitat mapping purposes. Detailed data also helps to recognize areas with great seabed diversity, and provides the information on the features easily lost in broader scales.

Coordinating Finnish Marine Data for EMODnet - MERTINET

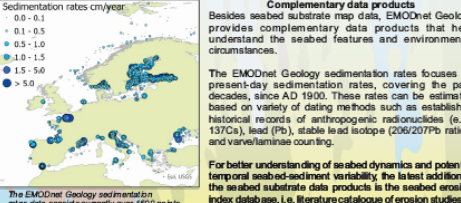
This joint project between the Geological Survey of Finland GTK and the Finnish Environment Institute (Syke), funded via the EMKVR programme, aims to strengthen Finland's production, coordination, and sharing of marine data. The work focuses specifically on *in situ* marine observations that fall within the scope of the European Marine Observation and Data Network (EMODnet). The project enhances national collaboration, supports international engagement, and promotes the accessibility of Finnish marine information.

Main Objectives:

- EMODnet Roadmap**
This component identifies where and by whom marine data is produced in Finland, how it is currently delivered to EMODnet, and what opportunities exist to improve collaboration and data flows toward EMODnet.
- Marine Data Security Assessment**
The assessment examines the conditions for sharing marine data, considering issues related to the Act on Territorial Surveillance and aspects of national security. This work is carried out in cooperation with the Defence Command of the Finnish Defence Forces.
- Organising National EMODnet Activities and Supporting International Participation**
This task develops Finland's national EMODnet coordination model among institutions delivering marine data to EMODnet. It also supports Finland's preparation for participation in the new EMODnet supporting organisation.

FINMARI Connection
The EMODnet Roadmap builds on existing resources, including the data management plan of the Finnish Marine Research Infrastructure (FINMARI), coordinated by Syke. In this connection, the project supports FINMARI's broader goal of strengthening the openness and accessibility of Finnish marine data. It also aims to review the existing instructions and other resources for using EMODnet data and develop them as needed.

Sedimentation rates cm/year



Besides seabed substrate map data, EMODnet Geology provides complementary data products that help understand the seabed features and environmental circumstances.


The EMODnet Geology sedimentation rates focuses on present-day sedimentation rates, covering the past decades, since AD 1900. These rates can be estimated based on variety of dating methods such as established historical records of anthropogenic radionuclides (e.g. 137Cs), lead (Pb), stable lead isotope (206/207Pb ratios) and varve/laminae counting.

For better understanding of seabed dynamics and potential temporal seabed-sediment variability, the latest addition in the seabed substrate data products is the seabed erosion index database, i.e. literature catalogue of erosion studies.

Over its fifteen years of existence, EMODnet Geology has become a leading producer of publicly available marine geological datasets, covering broad European areas and beyond, with a widely recognized methodology. The continuous development of old and new data products, such as Organic carbon content of sediments, ensures the ongoing relevance of EMODnet data for future applications.

Acknowledgements:

The EMODnet Geology project is funded by The European Climate, Environment and Infrastructure Executive Agency (CINEA) through contract CINEA/EINF/AF/147/2021-2023/05 for European Marine Observation and Data Network (EMODnet) - Lo2/CINEA/2024/010006 (Geology)



MERTINET project is funded via EMKVR programme

Co-funded by the European Union

GTK Suomen ympäristökeskus Finnish Environment Institute

FinMARI Finnish Marine Research Infrastructure

A WEB-BASED TOOL FOR THE EFFECTIVE INTEGRATION OF ECOSYSTEM FUNCTIONING INTO MARINE CONSERVATION AND SPATIAL PLANNING

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²Estonian Institute of Marine Research, University of Tartu

- ✓ Spatial analysis of biological communities and energy fluxes, aiding in assessments of how cumulative impacts and shifts in biodiversity translate into ecosystem functioning

Analysing Finnish Glider Data with unsupervised Machine Learning Algorithms

Kimmo Tikka, Ivia Closset, Laura Tuomi
Finnish Meteorological Institute

With increasing amount measured profiles we tried to answer a question:

"How do we identify (dis-)similar profiles of glider data?"

For this, we applied unsupervised learning methods to the glider data.

We may use our results to:

- 1) Quality check (glider) profiles data,
- 2) Find anomalies using several parameters,
- 3) Recognize dynamical changes in the ocean,
- 4) Evaluate ocean models,
- 5) Automate glider piloting and
- 6) Optimize data transmission

Introduction

The Baltic Sea is a shallow marginal sea with stratified brackish waters. It consists of consecutive sub-basins that are separated by underwater sills. The Central Baltic Sea's deep waters are in environmentally poor condition, but the basins of the Åland Sea and the Gulf of Bothnia are still ecologically healthy. Thus water exchange, especially deep water exchange is important. Since 2016, as a part of FMI's study on the water exchange between the underwater sills separated sub-basins of the Baltic Sea, we have deployed our Slocum G2 and Slocum G3 gliders for 11 up to one month and several hundreds of kilometres long missions in the Bothnian Sea area collection over 43000 profiles.

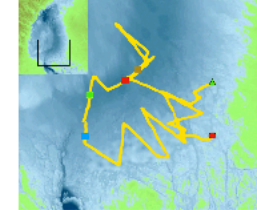


Figure 2: The Bothnian Sea and the path of the BS2019 mission. Profile sample positions marked with a square.

The path of our BS2019 mission first followed the southern slope of the Bothnian Sea's deep and the deep itself, collecting more than 6200 profiles of which we chose four groups of profiles with various profile shapes for further analysis.

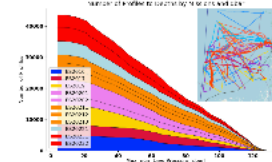


Figure 1: FMI glider missions in the Bothnian Sea.

Autonomous measurements with gliders and ARGO buoys produce the majority of oceanographic observations. Temporally and spatially dense measurements enable a more accurate picture of the state of the sea and subsurface processes. Huge datasets also give opportunities to improve the models in use. However, a large number of profiles means new challenges for quality control. Effective detection of dynamical processes and anomalies from vast datasets requires new processing methods.

Study area and data

Our research area is the Bothnian Sea, the Southern part of the Gulf of Bothnia. Regular monitoring stations are visited three to four times a year in the area. The intermediate, above the halocline waters, of the Baltic Proper usually flow to the North along the basins and are supposed to keep the deep waters of the Bothnian Sea fresh and healthy.

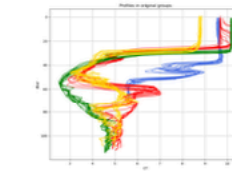


Figure 3: The groups of the study sample CT-profiles.

Methods

This study used unsupervised machine learning algorithms to cluster the profiles according to their shape. Our method, the Dynamic Time Warping (DTW) algorithm and KMeans clustering, has been widely recognized as an efficient but computationally extensive method for clustering.

Results

In cluster analysis, an important decision is how many clusters to use, which metrics and algorithm to use. In our limited test case, using 6 clusters gave satisfactory results. Groups 1 and 4 were classified into two clusters 1&3 and 2&5, and groups 2 and 3 dropped into clusters 4 and 0.

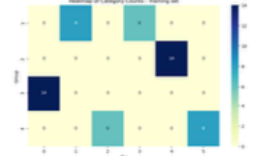


Figure 4: The heat map of the sample of 56 profiles.

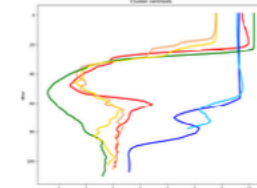


Figure 5: Cluster centroids with 6 clusters.

Using the centroids of the cluster, we can calculate distances between them and the profiles of the example segment.

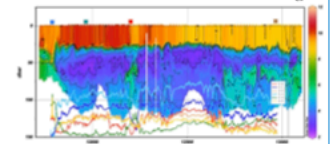


Figure 6: Sample segment of BS2019 and profiles dtw-distances to cluster centroids. Profile sample positions marked with a square.

Conclusions

Our use of KMeans clustering with DTW in analyzing glider datasets is a novel approach. Even with a small test sample and just six clusters, we were able to demonstrate how the profiles of an example segment can be meaningfully classified. This opens up exciting possibilities for further analysis, particularly with multivariate profiles of varying lengths.

Comparing methods of phytoplankton quantification

Vanharanta M.¹, Kraft K.¹, Impiö M.², Seppälä J.¹, Haraguchi L.¹

¹Research Infrastructure, Finnish Environment Institute

²Quality of Information, Finnish Environment Institute

We compare cell counts, particle size distributions, and biovolume estimates obtained using **light microscopy**, **pulse-shape recording flow cytometry**, and **imaging flow cytometry**.

Comparing methods of phytoplankton quantification



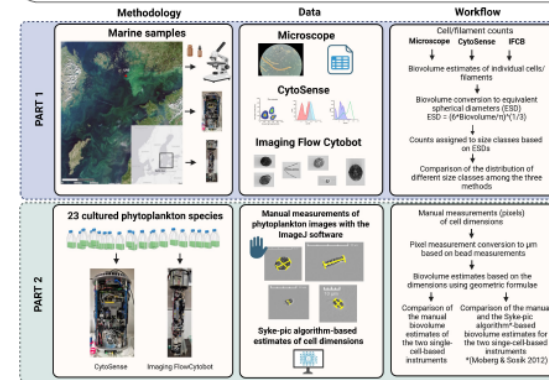
Mari Vanharanta, Kaisa Kraft, Mikko Impiö,
Jukka Seppälä & Lumi Haraguchi

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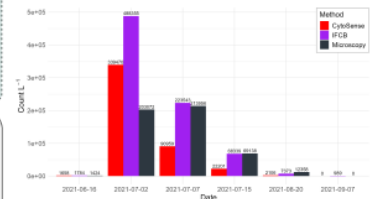


During the past decade, the traditional phytoplankton quantification method, light microscopy, has been complemented by single-cell-based techniques but comparisons among these methodologies remain limited. The pulse-shape recording flow cytometry provides distinction of functional groups whereas imaging flow cytometry combines the high throughput of flow cytometry with the imaging capabilities of microscopy, offering a significant potential to enhance the monitoring of marine microbial populations. This study assesses outputs of different phytoplankton quantification methods: the pulse-shape recording CytoSense (CytoBuoy), the Imaging FlowCytobot (McLane Labs) and light microscopy.

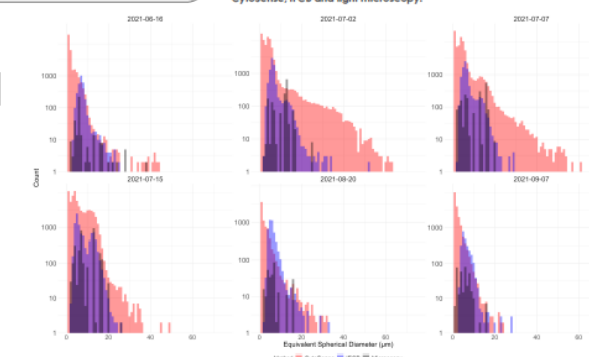
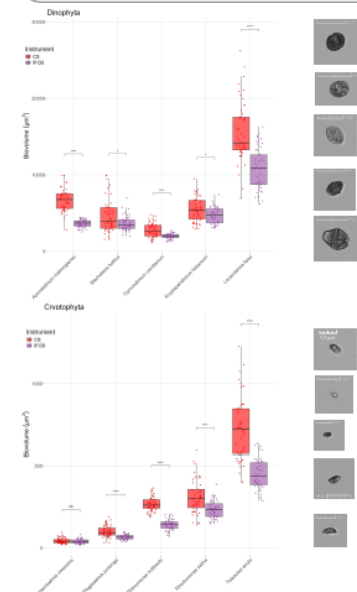


Research questions

- What are the main differences in performance among the three phytoplankton quantification methods?
- What are the main sources of uncertainty associated with each method across its analytical workflow?
- How does the choice of instrument influence the final biovolume estimates?
- How comparable are manual vs algorithm-based biovolume estimates?
- How does the selected method affect the interpretation of ecological patterns?



- Microscopy**
- + High taxonomic accuracy
 - + Established methodology, long traditions
 - Low sampling frequency
 - Slow sample processing time
 - Sample preservation needed
- Flow cytometry**
- + High sampling frequency
 - + Fast processing of samples *in vivo*
 - + Possibility for autonomous deployment
 - Uncertainties in biomass estimation



Conclusions

- Differences in the detected counts of filamentous cyanobacteria may stem from, e.g., the varying size ranges of particles analysed by each method.
- Pairwise comparisons of manually measured biovolumes from the two single-cell-based techniques (IFCB and CytoSense) show significant differences for most cultured species.
- The distribution of equivalent spherical diameter (ESD, μm) of all observed particles is comparable among the three methods.

Syke-pic - Plankton image classification at Syke - biovolume estimation code adopted to CytoSense images

FINMARI Finnish Marine Research Infrastructure <https://www.finmari.fi>

OBAMA-NEXT Observing And Mapping marine ecosystems - NEXT generation tools <https://obama-next.eu>

Reference

Moberg & Soikk (2012) Distance maps to estimate cell volume from two-dimensional plankton images. *Limnol. Oceanogr.* Methods 10: 270-285.



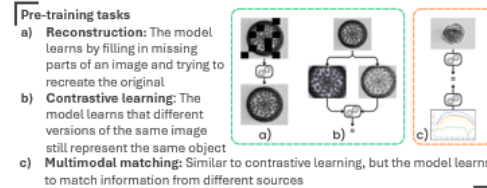
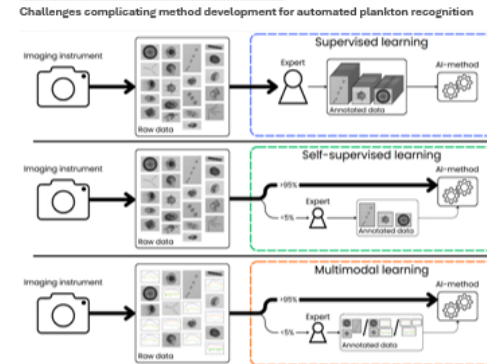
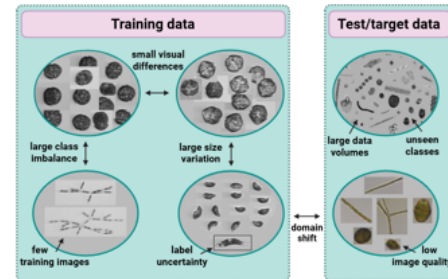
Life in the Fast Lane: challenges and solutions in automated phytoplankton analysis in the Baltic Sea

Kraft K.¹, Haraguchi L.¹, Suikkanen S.¹, Seppälä J.¹, Hällfors H.¹, Eerola T.², Kareinen J.², Immonen V.², Lensu L.², Kälviäinen H.^{2,3}

¹Finnish Environment Institute; ²Lappeenranta Lahti University of Technology; ³Brno University of Technology

- ✓ Automated flow and imaging flow cytometry instruments enable the collection of novel high-frequency phytoplankton information
- ✓ Several issues persist, hampering the steps towards operational use of automated plankton observations and automated recognition
- ✓ Open set classification opens the venue for the detection of taxa unprecedented in the training set (e.g., different seasons/locations)
- ✓ Detection of anomalies enables going beyond taxa (e.g., detection of the presence of parasites)
- ✓ Pre-training with large amounts of unlabeled data is beneficial for small classes
- ✓ Development of multi-modal classification methods allows classification of auxiliary data (e.g., pulse shape profiles without images)
- ✓ Efforts for harmonized labeling and to minimize label uncertainty are an important foundation for developing automated recognition

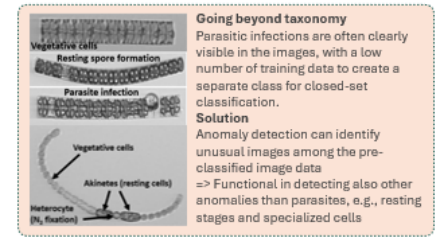
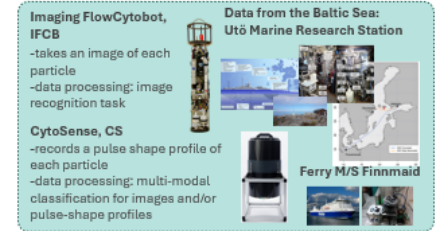
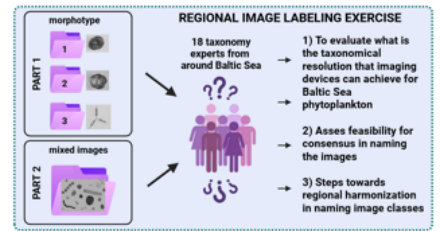
Automated flow and imaging flow cytometry enable the collection of high-frequency data, facilitating the observation of multiscale dynamics of phytoplankton in time and/or space, which are needed to understand the complex and swiftly changing phytoplankton communities. The unprecedented data volumes require novel methods for automated processing of raw data into ecologically meaningful information. Data flows and classification algorithms for automated data processing have been developed in the nationally funded projects FASTVISION and FASTVISION-plus. We reviewed previously developed methods for automated plankton recognition, identifying nine issues hampering the steps towards operational use. Our work highlights the development of automated recognition methods utilizing unlabeled pre-training, identifying anomalies (e.g., parasites), and architectures for multi-modal and open set classification systems. We also collaborate with regional phytoplankton experts to assess the uncertainty in annotated datasets and to aim at harmonizing the labeling. The results can be applied to other aquatic environments and organisms.



References:
 Eerola et al. (2024) Survey of automatic plankton image recognition: challenges, existing solutions and future perspectives DOI:10.1007/s10462-024-10745-y
 Kareinen et al. (2025) Self-supervised pretraining for fine-grained plankton recognition DOI:10.48550/arXiv.2503.11341
 Kareinen et al. (2024) Open-set plankton recognition DOI:10.1007/978-3-031-91672-4_11
 Batrakhonov et al. (2024) DAPlankton: Benchmark dataset for multi-instrument plankton recognition via fine-grained domain adaptation DOI:10.1109/CIP51287.2024.10648228
 Biik et al. (2023) Toward phytoplankton parasite detection using autoencoders DOI:10.1007/s00138-023-01450-x

The research was carried out in the Research Council of Finland-funded projects FASTVISION and FASTVISION-plus (Decision numbers 321980, 321991, 339612, and 339203), and Mission Europe project OBAMA-NEXT (Grant Agreement No. 101081642)

- Research highlights**
- Several issues persist, hampering the steps towards operational use of automated plankton systems and recognition
 - Open set classification opens the venue for the detection of taxa unprecedented in the training set (e.g., different seasons/locations)
 - Detection of anomalies enables going beyond taxa (e.g., detection of the presence of parasites)
 - Pre-training with large amounts of unlabeled data is beneficial for small classes
 - Development of multi-modal classification methods allows classification of auxiliary data (e.g., pulse shape profiles without images)
 - Efforts for harmonized labeling and to minimize label uncertainty are an important foundation for developing automated recognition



Locally Significant Marine Underwater Nature Areas (PEMMA)

Finnish Environment Institute

Parks & Wildlife Finland

- Identifies locally significant marine underwater nature areas
- Areas are expert revised and all final selections are based on existing data
- Done in strong cooperation with local stakeholders
- End product easy to use in spatial planning and environmental management
- Can be replicated in other areas where species and habitat data are available



© Photo: Parks & Wildlife Finland, Jaakko Haapamäki, 2023

PEMMA process in a nutshell

- Identifies locally significant marine underwater nature areas
- Areas are expert revised and all final selections are based on existing data
- Done in strong cooperation with local stakeholders
- End product easy to use in spatial planning and environmental management
- Can be replicated in other areas where species and habitat data are available

Locally Significant Marine Underwater Nature Areas (PEMMA)

The Locally Significant Marine Underwater Nature Areas (Finnish acronym: PEMMA) are a locally scaled application of the EBSA (Ecologically or Biologically Significant Marine Areas) process, defined by the UN Convention on Biological Diversity (CBD). The PEMMAs are produced under Velmu – the Finnish Inventory Programme for Underwater Marine Diversity.

PEMMA is a local application of EBSA

PEMMA are identified based on the criteria used in the CBD EBSA process, describing the uniqueness of the areas, their importance to species' life cycles, significance for endangered species or habitats, sensitivity of ecological components, biological diversity, and naturalness.

The same criteria have also been used at the national level, to describe Ecologically Significant Underwater Marine Areas (Finnish acronym: EMMA) in 2020 (Fig. 1). EMMA were used in the maritime spatial plans of Finland.

The preparatory work of PEMMA is supported by statistical models, spatial prioritization by Zonation, existing and new underwater nature observation data, literature, and expert knowledge.

Area delineations are developed in workshops in collaboration with marine nature experts and local stakeholders. The final PEMMA delineations are always based on existing data.

Many cities and municipalities in Finland have strategic goals related to sustainable area use and nature conservation. PEMMAs support reaching these goals, for example, by informing about the locations of valuable nature features.

The EMMA and PEMMA processes have been described in reports (Lappalainen et al. 2020; Kuismanen et al. 2023, 2024), and they can be replicated in any sea area, from which sufficient data on underwater nature exists.

Archipelago Sea PEMMA – The Second PEMMA process in Finland

The first PEMMA process was completed in 2024 as a pilot for the Capital City area (Fig. 2), where 22 ecologically significant areas were identified. The three most frequently met criteria were endangered status of species or habitat types, biological diversity, and areas of importance for life cycles.

In the Archipelago Sea PEMMA (Fig. 3), the same process is repeated to identify the locally most significant marine underwater nature areas in a larger area encompassing 10 municipalities. The work is currently ongoing, and the results will be made public in August 2026 (Fig. 4).



Fig. 4. Timetable for Archipelago Sea PEMMA

References:
Lappalainen et al. 2020. Suomen ekologisesti merkittävät vedenalaiset meribiotoosit (EMMA). SYKE Rap 6/2020
Kuismanen et al. 2023. Identifying ecologically valuable marine areas to support conservation and spatial planning at scales relevant for decision making. Marine Policy 158: 105890
Kuismanen et al. 2024. Paikallisesti ekologisesti merkittävien vedenalaisien meribiotoositien tunnistaminen. SYKE Rap. 13/2024

Funding by the Ministry of the Environment of Finland for the Velmu Programme and the PEMMA project

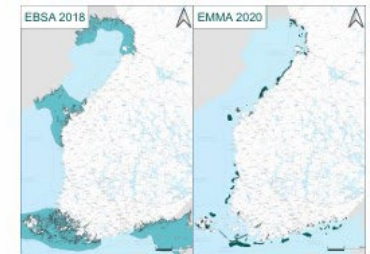


Fig. 1. Four CBD EBSA areas in the northern Baltic Sea (left); 87 national EMMA areas in Finland (right)

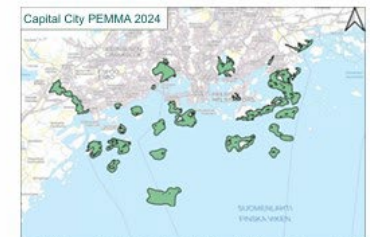


Fig. 2. Result of the first PEMMA process in the Capital City area: PEMMA areas in Helsinki and Espoo

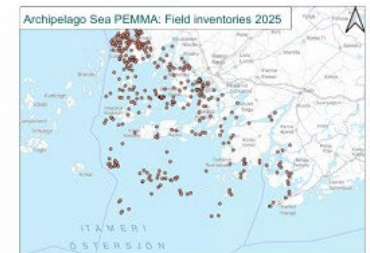


Fig. 3. Additional field inventories in the Archipelago Sea done in 2025. Each inventory point is a 100 metres long dive transect

Muddy bedforms and Sediment Dynamics in the Lapuanjoki Estuary in the Baltic Sea

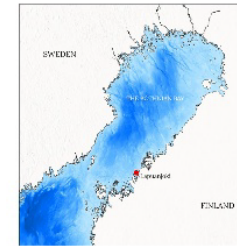
Meri Sahiluoto, Aarno Kotilainen, Marine Poizat
Geological Survey of Finland

- ✓ Elongated muddy dune-like formations were revealed in the Lapuanjoki estuary during multibeam surveys
- ✓ Preliminary analyses show trends consistent with the bathymetry
- ✓ Further work requires detailed information on sediment transport
- ✓ The Interreg Aurora-funded HIDDEN project will continue this research using a benthic lander

Muddy bedforms and Sediment Dynamics in the Lapuanjoki Estuary in the Baltic Sea

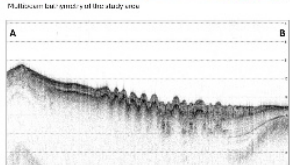
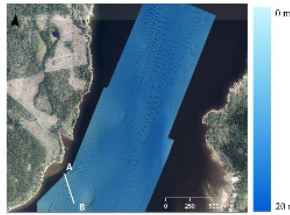
Baltic Sea estuaries remain poorly studied geologically, leaving major gaps in understanding their seafloor features and environmental conditions. This knowledge is essential for interpreting local species and their habitats. Identifying these gaps supports the EU Nature Restoration Law and improves conservation and restoration efforts. Northern Baltic estuaries are shallow, dynamic systems shaped by ice cover, sea-level changes, and river-borne sediments. Human activities such as agricultural runoff and construction of jetties can alter sediment transport and increase the buildup of toxins and other harmful substances.

Multibeam surveys

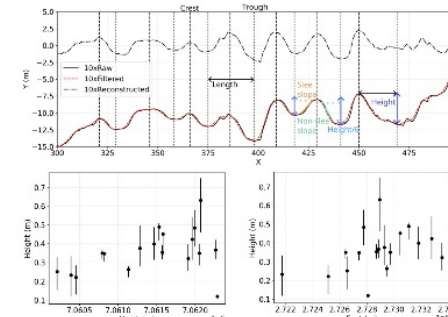


The Lapuanjoki estuary is a predominantly shallow coastal system where **fine sediments** accumulate near the river mouth and wave-driven processes increasingly influence the seabed offshore. As part of the Finnish-Swedish SeaMoreEco project (2023–2025), seafloor characteristics and bathymetry were mapped using a R2Sonic 2022 **multibeam echosounder**, **sediment sub-bottom profilers**, **reflection seismic sounding**, and **side-scan sonar**. The data were collected and processed using Meridata software. The study utilized research infrastructure facilities provided by FINMARI.

The study revealed a field of **elongated linear bedforms** within a narrow channel opening toward the sea. The seabed is primarily composed of **organic-rich mud**. In exposed areas, there are linear wavy bedforms with heights of 0.1–0.6 m and wavelengths of ~10 m. These dunes, composed of **mixed mud and gyttja clay**, extend for nearly one kilometre and show minimal movement between two different surveys (in 2024 and 2025), indicating high bedform stability. Their orientation is likely influenced by dominant currents, wind-driven flows, wave action, and sediment cohesiveness, although the controlling factors remain uncertain.



Dune analysis



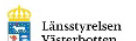
The dunes morphology was characterized using the DEM of the study area. Preliminary analyses indicate spatial variability in dune morphology even within this small region. In the northern part of the area, the dunes are higher and exhibit steeper slopes, whereas in the south they are lower with more gentle gradients. The dunes are also higher on the eastern side compared to the western side.

HIDDEN project

A new Interreg Aurora-funded project called HIDDEN (Habitat Investigation in Diverse and Dynamic Estuarine Networks) beginning in 2026 will continue this work, enabling further investigation of sediment dynamics in the Lapuanjoki estuary. The project will deploy a benthic lander equipped with sensors capable of quantifying organic and inorganic particle fluxes of the benthic layer. The measurements will improve understanding of sediment transport processes and their role in maintaining and shaping the observed dune structures. Upcoming studies will include sediment transport measurements to assess **particle size distribution**, **particle concentration**, **current velocity** and **centimeter-scale seafloor change**. Future work will also focus on refining the data for more detailed bedform analysis.



Authors: Sahiluoto, M., Kotilainen, A.T., Poizat, M.
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Effects of a novel invasive predator on invertebrate community across decades

Lars Pelikan¹, Amy E. Fowler², Eino Nousiainen¹, Niklas Kjell Ratajczak¹, Veijo Jormalainen¹

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²George Mason University, Environmental Science & Policy Department, 4400 University Drive, Fairfax, VA 22030, USA

- ✓ The invasive crab *Rhithropanopeus harrisi*, a novel predator, is increasing its distribution range in the Archipelago Sea
- ✓ Many native littoral invertebrate species decrease in abundance following the invasion
- ✓ Community composition shifts from grazer dominated towards deposit feeder dominated communities

Effects of a novel invasive predator on invertebrate community across decades

Lars Pelikan^{1*}, Amy E. Fowler², Eino Nousiainen¹, Niklas Kjell Ratajczak¹, Veijo Jormalainen¹

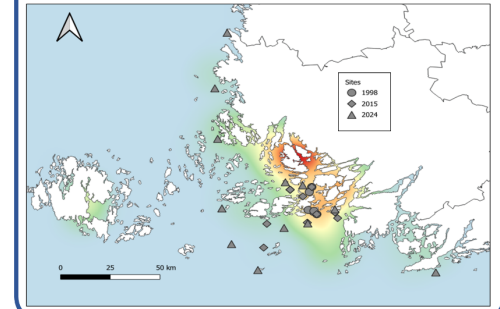
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Research questions

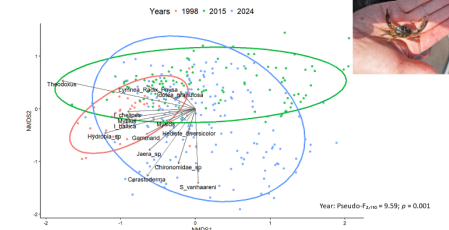
- Has *Fucus*-associated macroinvertebrate community composition in the Archipelago Sea shifted over decades?
- If so, can the shift be explained by the introduction of the novel predator *Rhithropanopeus harrisi*?

Methods

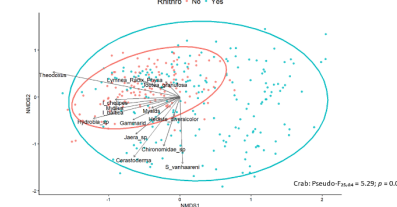
- In 1998, 2015 and 2024, *Fucus vesiculosus* thalli (n=10-20) were collected from several sites by enclosing the thallus in a mesh bag underwater and cutting the stipe at the distal disk.
- All associated invertebrate species were identified and counted.



Results



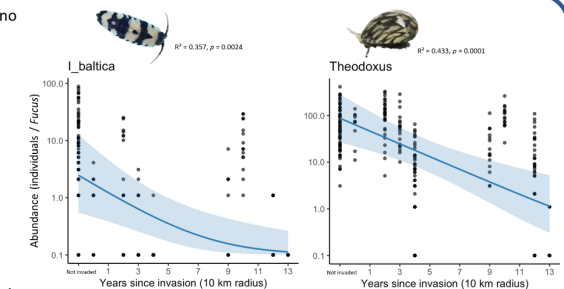
Community composition shifted from little variation and no crab in 1998 towards much more variable composition in invaded years (arrows indicating increasing abundance)



Sites with *R. harrisi* have a much more variable community composition than sites without it



Community composition has shifted gradually with the duration of invasion of *R. harrisi*



Abundance of *I. baltica* and *T. fluviatilis* has decreased with years since invasion of *R. harrisi*

Conclusion

- Community composition is shifting from grazer dominated towards deposit feeder dominated communities
- This shift in community composition can be explained by the invasion of *R. harrisi*

Temporal changes in total cyanobacteria biomass in the Northern Baltic Sea during July—August 1991—2023

Rousi H., Fält-Nardmann J., Marjamäki B., Niemelä P., Hänninen J.

University of Turku, Department of Biodiversity Sciences

- ✓ Samples collected 1—3 times a month
- ✓ Total cyanobacteria biomass increased
- ✓ Biomass change correlated with climatic variables
- ✓ Strong response to winter NAO
- ✓ Also a response to SST, phosphate and wind speed

Temporal changes in total cyanobacteria biomass in the Northern Baltic Sea during July—August 1991—2023

Rousi H., Fält-Nardmann J. J., Marjamäki B., Niemelä P. & Hänninen J.

The researchers work at the University of Turku, Department of Biodiversity Sciences.

Preface

We studied temporal effects of eutrophication and climatic variables on total cyanobacteria biomass from mid to late summer in the Archipelago Sea, Northern Baltic Sea. The results are based on phytoplankton samples, collected at least once a month.

Here we present the main results.

Highlights

Total cyanobacteria biomass has significantly increased in the Archipelago Sea during July—August in the last three decades (Fig 1). The rise correlates with climatic variables (Table 1).

Table 1. Statistical values, based on GLMM3 model (SAS), for surface water T, winter NAO, phosphate phosphorus and high wind during sampling day at the sampling location.

Variable	Estimate	STE	DF	p-value
Temperature	0.17	0.07	25.45	0.02
Winter NAO	-0.94	0.09	23.45	<0.0001
Phosphate	-0.42	0.15	31.07	0.03
High wind	-0.17	0.04	25.3	0.0003



Fig 2. A) *Aphanizomenon flos-aquae* cyanobacteria bloom in the Archipelago Sea. Photo by Jaakko Rousi. B) *Anabaena* spp. cyanobacteria. Photo by Culture Collection of algae and protozoa.

Acknowledgements

The Archipelago Research Institute (SELI) collaborates with FINMARI consortium. The study uses FINMARI consortium resources for the research equipment and data collection. SELI is also part of European Marine Biological Resource Centre (EMBRIC).

We thank the Economic Development Centre of Southwest Finland for phytoplankton sample laboratory analyses.

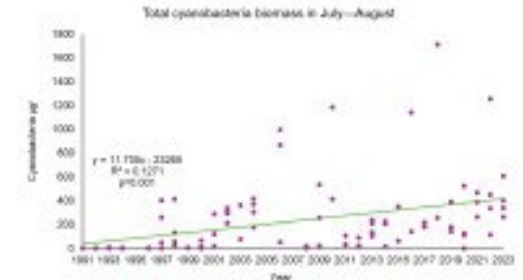


Fig 1. Total cyanobacteria biomass (µg/l) in the Sell intensive monitoring station during July—August 1991—2023. Trendline is calculated by linear regression.

Results & Conclusions

- Surface water temperature correlated positively with total cyanobacteria biomass. On the contrary winter NAO, phosphate phosphorus and high wind (m/s) correlated negatively with cyanobacteria biomass (Table 1).
- It is known that cyanobacteria benefit from warmer water temperatures, and their biomass are greatest in mid—and summer.
- After warmer winters with a more positive NAO index, there is no high peak in spring floods. Thus, the nutrients leaching from catchment area begins earlier and stands longer.
- Nutrients in the seawater have more time to bind to growing biomass of phytoplankton and macrophytes. By midsummer, when the seawater is warm, there is no free inorganic phosphorus left in the seawater for cyanobacteria to exploit.
- Cyanobacteria proliferate in serene conditions: that, windy conditions do not favour bloom formation.
- These results reflect combined effects of eutrophication and climate change for the optimal conditions of cyanobacteria in the northern Baltic Sea during mid—late summer.



Linking phytoplankton traits and air-sea carbon exchange

A.M. Lewandowska, P. Hedberg, C. Uth, M. Brunberg, N-X. Geilfus

Tvärminne Zoological Station, University of Helsinki

- ✓ Spring diatom bloom accumulates nearly double amount of carbon compared to cyanobacteria bloom
- ✓ Methane emissions contribute $< 0.5\%$ to the total carbon flux, even under most extreme warming scenario with the highest cyanobacteria dominance

LINKING PHYTOPLANKTON TRAITS AND AIR-SEA CARBON EXCHANGE

ALEKSANDRA M. LEWANDOWSKA, PER HEDBERG, CATHARINA UTH, MÄRTA BRUNBERG, NICOLAS-XAVIER GEILFUS

TVÄRMINNE ZOOLOGICAL STATION, UNIVERSITY OF HELSINKI

RATIONALE

Phytoplankton blooms are considered a major carbon sink on Earth, yet climate warming and changing phytoplankton community composition both affect their carbon accumulation capacity and export to the seafloor.

We quantified CO_2 and CH_4 fluxes in seasonal mesocosm warming experiments with natural and manipulated Baltic Sea plankton assemblages to test:

- (1) What proportion of carbon is accumulated by the phytoplankton bloom, and
- (2) Whether meaningful methane emissions can be detected

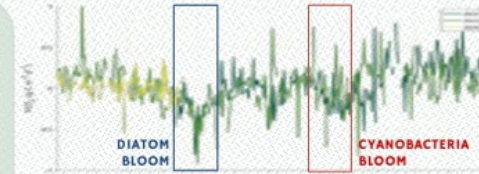


Figure 1. Daily air-sea fluxes of CO_2 measured at the Eddy covariance flux tower offshore Tvärminne Zoological Station (Vähä et al. in prep.). The blue and red boxes correspond to the timing of the experiments in 2023.



DIATOM BLOOM

Spring diatom bloom accumulated nearly double amount of carbon compared to the summer cyanobacteria bloom, and warming by 4.8°C increased carbon uptake rates by $\sim 20\%$. Methane emissions contributed $< 0.5\%$ to the total carbon flux in both temperature scenarios. Decrease in diatom dominance for the benefit of dinoflagellates did not have significant effects on carbon fluxes.



CYANOBACTERIA BLOOM

Carbon turnover during summer cyanobacteria bloom was faster than in spring, leading to higher CO_2 and CH_4 emissions. Warming by 4.8°C initially turned the experimental ecosystem into carbon source, but this effect did not correspond to the enhanced proportion of cyanobacteria, suggesting that higher metabolic activity of heterotrophs and mixotrophs with warming might have been the primary cause of carbon emissions.

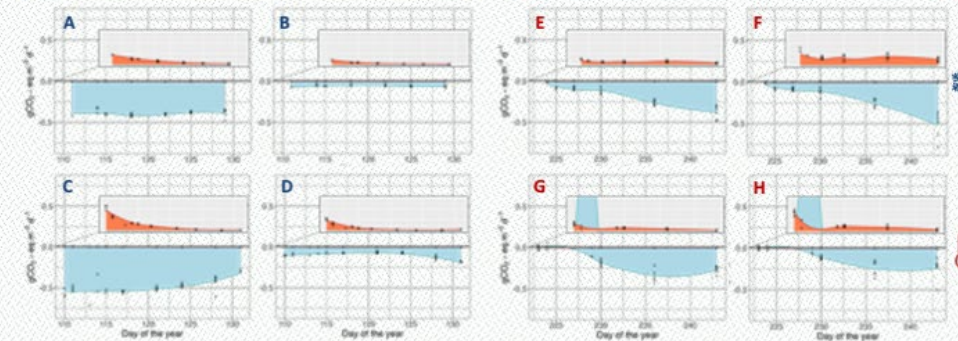


Figure 2. Daily net carbon fluxes [A, C, E, G], and daily net carbon fluxes normalized by phytoplankton biomass [POC mol:mol]; B, D, F, H] during diatom [A-D] and cyanobacteria [E-H] bloom at ambient [A, B, E, F] and $+4.8^\circ\text{C}$ warming [C, D, G, H] scenario. CO_2 in blue and CH_4 in red. CH_4 trends are zoomed in for better visibility. Saltires represent sampling occasions (with replicates). 100-years CO_2 equivalent was used for CH_4 quotas.

METHODS: The indoor mesocosm experiments (one during the spring diatom bloom and one during the summer cyanobacteria bloom) lasted five weeks, during which gas fluxes of CO_2 and CH_4 (using gas accumulation chamber technique), particulate organic carbon, and other biological and environmental variables were measured. At the beginning of the experiments phytoplankton community composition and temperature were manipulated to mimic future warming ($+4.8^\circ\text{C}$) scenarios that included predictions of changing plankton community composition towards weaker diatoms dominance in spring and greater cyanobacteria dominance in summer. Generalized last square models (GLS) accounting for temporal autocorrelation and heteroscedasticity were applied to test statistical significance.

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KONEEN SÄÄTIÖ
KONE FOUNDATION



Integrating Molecular and Physiological Approaches for Climate-change Tolerance in Seagrass

Sarah Rühmkorff, Giannina Hattich, Christian Pansch
Åbo Akademi University

- ✓ Microclimates shape thermal performance of seagrass
- ✓ Seagrass interaction with bivalves can influence seagrass thermal performance
- ✓ Non structural carbohydrates in seagrass below and aboveground biomass can help to predict seagrass performance
- ✓ Investigation of thermal performance of seagrass is important to determine seagrass ability to tolerate changing temperatures in future

Geodiversity of the Åland Seafloor: Geological Mapping for Biodiversea LIFE IP

Virtanen, S., Jokinen, S., Kaskela, A., Sahiluoto, M., Sainio, A. and Sanila, N.
Geological Survey of Finland

- ✓ The aim of the project is to strengthen the ecological state of the Baltic Sea
- ✓ Fieldwork in the four study areas combined seismo-acoustic methods and surface sediment sampling
- ✓ Geological mapping revealed a diverse and active seabed, with contrasting hard and soft substrates that can support a wide range of seafloor habitats

Authors: Virtanen, S., Jokinen, S., Kaskela, A., Sahiluoto, M., Sainio, A. and Sanila N.
Geological Survey of Finland, Environmental Solutions,
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Introduction

The Biodiversea LIFE IP project (2021–2029) brings together a broad group of organizations working to strengthen the ecological state of the Baltic Sea and promote sustainable marine use. As part of this project, GTK has conducted detailed marine geological surveys in the waters surrounding the Åland Islands, producing information that supports local conservation and planning (Fig. 1). The project is coordinated by Metsähallitus and implemented in cooperation with GTK, BSAG, SYKE, the Ministry of the Environment, LuKe, Turku University of Applied Sciences, Åbo Akademi University and the Åland Provincial Government.



Figure 1. LIFE IP Biodiversea Marine Geological study areas

Methods

Fieldwork in the four study areas combined several seismo-acoustic methods to map the seafloor (Fig. 1 & 2). Surface sediment samples were collected to confirm and refine the geological interpretations derived from the acoustic data. Together, these datasets provide a detailed picture of seabed geodiversity, seafloor topography, and the range of seabed substrates present.

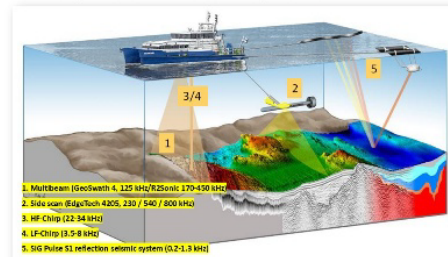


Figure 2. Marine Geological seismo-acoustic survey methods.

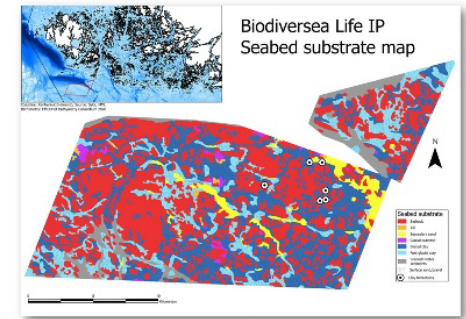


Figure 3. Seabed substrate map of Southern Åland study area.

Results & Discussion

The Southern study area (Fig. 3) is dominated by rocky reefs formed by exposed bedrock, with clay-filled depressions between them typically covered by a thin layer of sand. These sediment patterns indicate an energetic environment where waves and currents actively rework the seafloor, limiting the accumulation of finer material.

Ferromanganese concretions occurred at a few sites, indicating locally low sedimentation rates and oxygenated bottom conditions that allow their slow formation. In the northeast, clay labyrinths were identified, likely formed by erosion of exposed clay surfaces and reflecting long-term stability of these deposits. Their overall occurrence in the Baltic Sea is poorly known, as only a few such features have been documented.

Together, these features show a geologically diverse and active seabed, with contrasting hard and soft substrates that can support a wide range of seafloor habitats.

The LIFE IP Biodiversea project has received funding from the LIFE Programme of the European Union. The material reflects the views by the authors, and the European Commission or the CNDA is not responsible for any use that may be made of the information it contains. Marine geological surveys have utilized research infrastructure facilities provided by FINMARI (Finnish Marine Research Infrastructure Network).

Temperate marine macrophytes are highly variable sources of Volatile Organic Compounds

Max Gräfnings, Yuanyuan Luo, Jian Zhao, Kirsten Fossum, Frans Graeffe, Lu Lei, Jurgita Ovadnevaite, Mikael Ehn, Camilla Gustafsson

Tvärminne Zoological Station, University of Helsinki,
University of Galway

- ✓ VOCs affect several chemical processes in the atmosphere that have profound climate impacts.
- ✓ Coastal VOC emissions are poorly constrained.
- ✓ Our results show that marine macrophytes emit diverse and atmospherically relevant VOC-profiles.

Temperate marine macrophytes are highly variable sources of Volatile Organic Compounds

Introduction

Biogenic Volatile Organic Compounds (BVOC), emitted by Earth's ecosystems, affect several chemical processes in the atmosphere that have **profound climate impacts**¹. However, marine BVOC-budget estimations are still inaccurate and poorly constrained. **Marine macrophytes** (i.e., macroalgae and seagrass) are a large and widespread organismal group whose **BVOC profiles & emission rates** are especially poorly quantified².

Objective
Quantify the BVOC emissions rates of common temperate macrophytes and examine how the emissions differ between species and across marine regions.

Max Gräfnings (max.graefn@gshelsinki.fi),
Yuanyuan Luo, Jian Zhao, Kirsten Fossum, Frans Graeffe, Lu Lei, Jurgita Ovadnevaite, Mikael Ehn, Camilla Gustafsson

Methods

The BVOC emission rates of three temperate macrophytes (*Zostera marina*, *Fucus vesiculosus* and *Ulva intestinalis*) were quantified *ex situ* with a PTR-ToF-MS (see Incubation setup). Quantifications were duplicated in two marine regions that vastly differ from each other (e.g., temperature, nutrients, salinity), the **eastern Atlantic** (Ireland) and **northern Baltic Sea** (Finland).



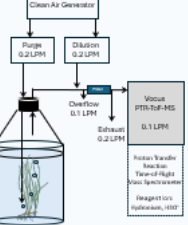
Experimental setup

Six treatments (n=5)

3 macrophytes * 2 marine regions

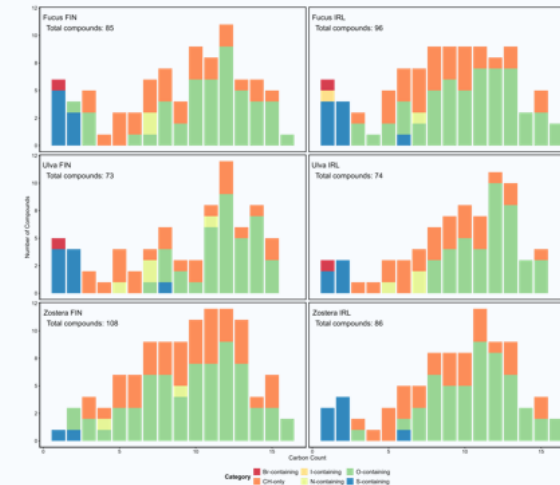


Ex situ incubation setup

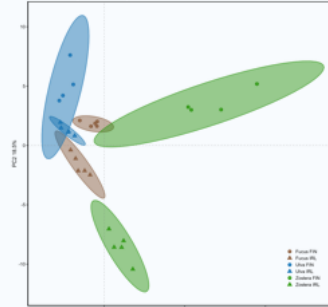


Results

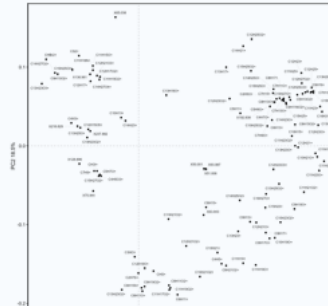
The studied macrophytes emitted **166 different BVOCs** in total. Majority of detected compounds were hydrocarbons (CH) or oxygenated hydrocarbons (CHO; see below), but all three species also emitted some sulphur- and nitrogen containing compounds. BVOC emissions differed significantly between the macrophyte species, but notably, also stark differences were found within-species between regions. In fact, a pairwise PERMANOVA showed that the **BVOC profiles** (see right) of most treatments **differed significantly** from each other (non-sig. exceptions: *Ulva* IRL & *Ulva* FIN, *Ulva* IRL & *Fucus* IRL).



Distribution of treatments in PCA space



Compound contributions to PCs



Conclusions

Marine macrophytes are highly variable BVOC-sources. Interestingly, variation is spread across several dimensions: 1. individual species emit a high number of unique compounds, 2. BVOC emissions differ significantly between macrophyte species, and 3. macrophytes emit distinct chemical profiles depending on their growth environment (Atlantic Ocean vs Baltic Sea). These results provide novel insights to how macrophytes can through their BVOC-emissions impact the environment both above and below the water surface.

Grazers' demise? Effects of the Invasive Crab, *Rhithropanopeus harrisi*, on Rocky Littoral Communities in the Northern Baltic

Eino Nousiainen, Nellie Paavola, Niklas Ratajczak, Heini Ukkonen, Lars Pelikan, Amy Fowler, Veijo Jormalainen

Department of Biology, University of Turku

- ✓ Spatially large-scale, quantitative study of the effects of the invasion of *R. harrisi* and its duration to epifaunal communities.
- ✓ Clear and fast changes to communities and species abundances in response to the invasion.
- ✓ No signs of community recovery with prolonged coexistence with the crab.
- ✓ Possible cascading effects to producer communities.

Grazers' demise? Effects of the Invasive Crab, *Rhithropanopeus harrisi*, on Rocky Littoral Communities in the Northern Baltic

Eino Nousiainen, Nellie Paavola, Niklas Ratajczak, Heini Ukkonen, Lars Pelikan, Amy Fowler, Veijo Jormalainen

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Based on the MSc-thesis of the first author - Read it here!

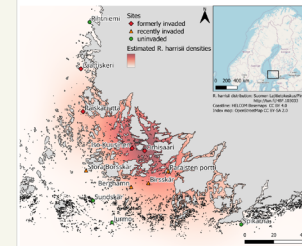
ejnous@utu.fi

Background

Invasive species in aquatic systems can be seriously detrimental to native populations and drive shifts in ecosystem functioning. Prior studies have suggested that a functionally novel invasive decapod, *Rhithropanopeus harrisi*, can drastically reduce mesoherbivore densities in rocky littoral habitats, but spatially large-scale quantitative studies are yet to be performed.

Methods

Sampling was performed at 12 rocky littoral sites in the Finnish SW archipelago, including the invasion range of *R. harrisi*. Using SCUBA divers, *Fucus thalli* were collected into mesh bags and all associated invertebrates counted and identified. Differences in communities and species abundances among sites having different invasion histories were analysed with **multivariate analysis** and **GLMM-models**, respectively.



How does the invasion of *R. harrisi* and its duration affect communities in the *Fucus* dominated rocky littoral habitats in the Northern Baltic?

➤ Focus on invertebrate epifauna

Community effects

The invasion history of *R. harrisi* affected community compositions significantly ($p < 0.05$), with a significant interaction between invasion history and depth ($p < 0.001$). Depth was important only in invaded sites, suggesting depth dependent impacts of the invasion.

Community changes were also accompanied by a slight decrease in H' diversity.

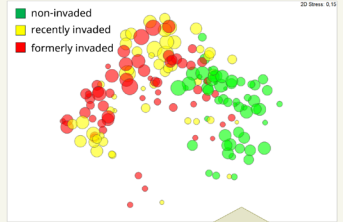
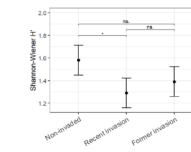


Fig. 1. NMDS ordination depicting differences in species composition between invasion histories using Brey-Curtis' similarities. Each bubble represents the invertebrate community inhabiting a single *F. vesiculosus* bush. Samples have been standardized and square root transformed. Bubble size increases with sample depth ranging from 0 cm to 400 cm.

Discussion

- In invaded areas, most motile herbivores declined, and filter feeders became the dominant taxa.
- Invasion effects seem to be partially depth dependent, due to the crabs' depth distribution or reduced shelter for herbivores at deeper depths.
- Even with prolonged coexistence with the crab there are no clear signs of community recovery.
- Crabs can suppress grazer populations to levels far below those expected from native predation, potentially affecting producer communities.

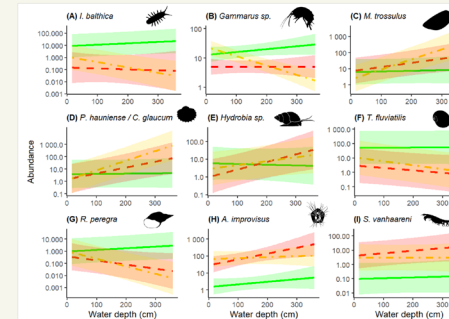


Fig. 2. Model-predicted mean H' diversities between invasion histories with 95% confidence limits and pairwise comparisons

Fig. 3. Model-predicted abundances (\pm 95% c.l's) for species along a water depth gradient among different invasion histories, indicated by color: non-invaded (green), recently invaded (yellow), formerly invaded (red)

Variations in benthic macrofauna along an exposure gradient in the Baltic Sea

Emma Holmback^{1,2}, Marie C. Nordström¹, Anna Villnäs³, Camilla Gustafsson³, Jenna Hölttä³, Leena Virta³, Tiina Salo^{1,2}.

¹Faculty of Biological and Environmental Sciences, University of Helsinki.

²Environmental and Marine Biology, Åbo Akademi University. ³Tvärminne Zoological Station, University of Helsinki.

- Water movement is known as a factor with potential to impact settlement of both fauna and vegetation, especially on intermediate scales
- AIM** – explore how biodiversity in benthic macrofaunal communities is connected to exposure
- Infauna and epifauna from eight vegetated sites (n=5) along an exposure gradient



Variations in benthic macrofauna along an exposure gradient in the Baltic Sea



Emma Holmback^{1,2}, Marie C. Nordström¹, Anna Villnäs³, Camilla Gustafsson³, Jenna Hölttä³, Leena Virta³, Tiina Salo^{1,2}.

¹Faculty of Biological and Environmental Sciences, University of Helsinki. ²Environmental and Marine Biology, Åbo Akademi University. ³Tvärminne Zoological Station, University of Helsinki.



COMMUNITY COMPOSITION RESPONSES TO WAVE EXPOSURE

- Water movement is known as a factor with potential to impact settlement of both fauna and algae^[1]
- On intermediate scales (within 10s of km) water movement and substratum has been argued to be of the most important abiotic factors for the composition of phytobenthic communities^[2]
- Previous studies have shown a connection between exposure and abundance of e.g. different amphipods and molluscs^[1]

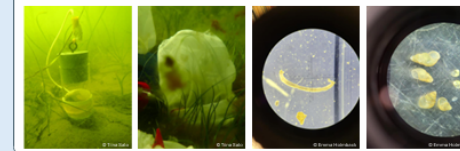
AIM – How is biodiversity in macrofaunal communities connected to exposure?

METHODS

Field work: Aug. 2024 Tvärminne Zoological Station

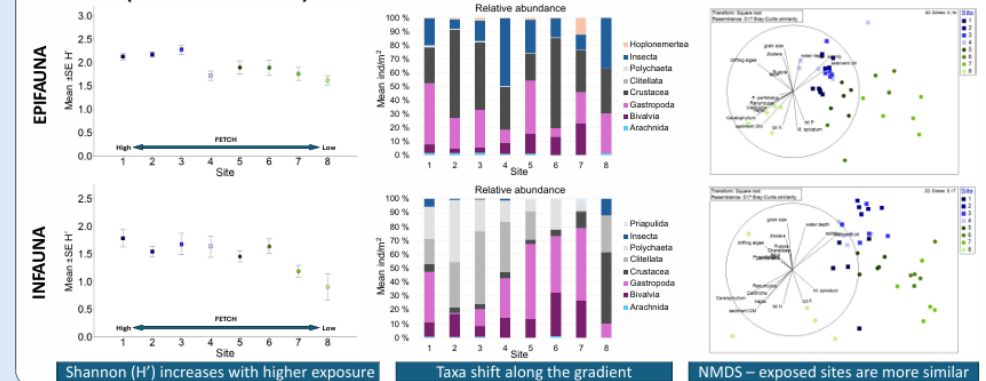
- Infauna and epifauna (n=5) + environmental variables and sediment properties from 8 vegetated sites

Lab work: abundance & dry weight of fauna and vegetation



Sites along an exposure gradient. Exposure based on calculated fetch with values ranging from 33477 (site 1) to 86 (site 8). Blue squares indicate high exposure (fetch >3000) and green circles low exposure (fetch <400).

RESULTS (abundance data)



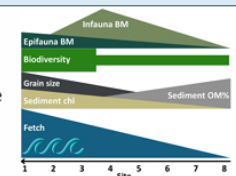
Shannon (H') increases with higher exposure

Taxa shift along the gradient

NMDS – exposed sites are more similar

KEY FINDINGS

- Biodiversity was higher with high exposure
- Grain size and water depth, combined with salinity and sediment chl for the more exposed sites and with sediment OM% for the more sheltered sites, had a strong connection with the community composition
- Wave exposure affected community composition both directly and indirectly through altering environmental variables along the gradient



[1] Wallin et al., 2011. Benthic communities in relation to wave exposure and spatial position on sublittoral boulders in the Baltic Sea. DOI: 10.1354/AM00205. [2] Kowalyk, H. (1995). Quantitative distribution of sublittoral plant and animal communities along the Baltic Sea gradient. ISBN: 951351208-7. [3] Tröner et al., 2022. Variation in Fauna and Vegetation Associated Benthos along a Vegetation Gradient. DOI: 10.3390/ma13023979.

ACKNOWLEDGEMENTS: We thank the University of Helsinki and Åbo Akademi University for excellent working facilities. This study utilized research infrastructure facilities at Tvärminne Zoological Station, University of Helsinki, as part of FINMARI (Finnish Marine Research Infrastructure consortium). Funding: Swedish Cultural Foundation & MAREES (MARine Biodiversity and Ecosystem Functioning leading to Ecosystem Services) funded through the European Union under the Horizon Europe Program (HORIZON-CIS-2021-BIODIV-01; grant agreement no. 101060993).

How Phytoplankton community shape Carbon Flux in the Baltic Sea

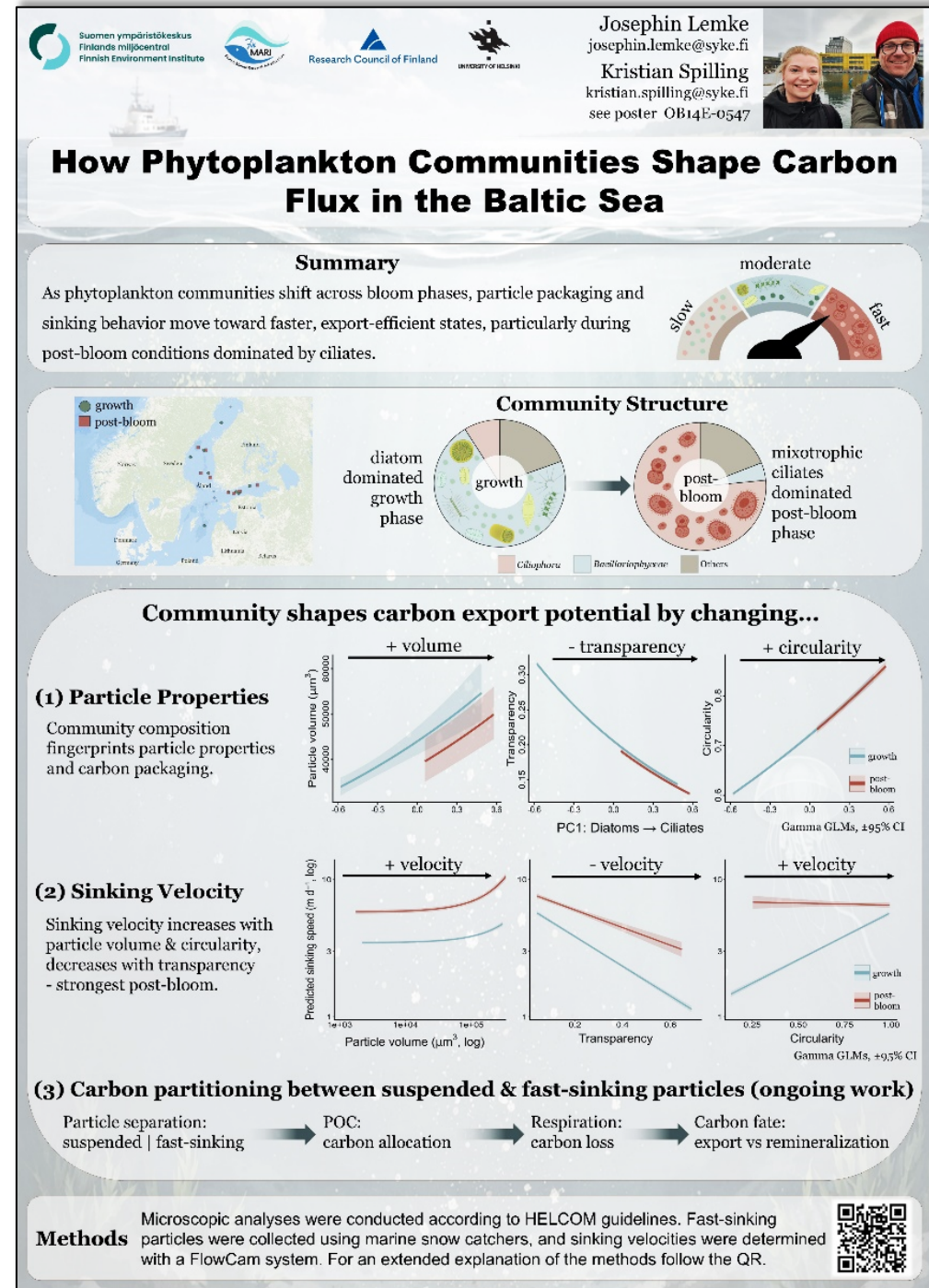
Josephin Lemke^{1,2}, Kristian Spilling¹

¹Finnish Environment Institute

²Tvärminne Zoological Station University of Helsinki

Finding: Community shifts affect particle packaging and sinking speed.

Implication: Post-bloom communities enhance carbon export efficiency.



Moving beyond traditional Blue Carbon approaches to understand links between coastal biodiversity and climate feedback

Alf Norkko & the www.coastclim.org collegium
University of Helsinki & Stockholm University


- ✓ We integrate marine ecology, biogeochemistry, and atmospheric science to understand the role of healthy vs. degraded coastal habitats for climate
- ✓ Super-site approach; co-location of long-term monitoring, developing infra and field & lab studies at Tvärminne

Open call
IRISCC TA!

Moving beyond traditional Blue Carbon approaches to understand links between coastal biodiversity and climate feedback

Alf Norkko¹, Mikael Ehn², Anna Villnäs³, Aleksandra Lewandowska⁴, Tom Jilbert⁵, Ivan Mammarella⁶, Camilla Gustafsson⁷, Roseline Thakur⁸, Nicolas-Xavier Gellfus⁹, Susanne Kortsch¹⁰, Ekaterina Ezhova¹¹, Joanna Norkko¹², Markku Kulmala¹³, Christoph Humborg¹⁴ and the www.coastclim.org collegium

University of Helsinki: ¹Tvärminne Zoological Station & ²Inst. for Atmospheric and Earth System Research & ³Dept. of Geosciences and Geography
Stockholm University: ⁴Baltic Sea Centre

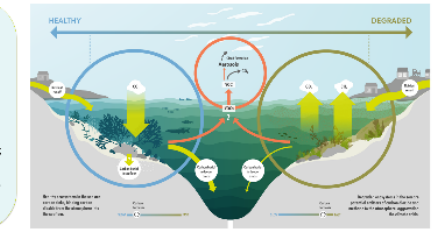


Blue Carbon research emphasizes long-term CO₂ burial in vegetated habitats, but coastal systems also emit methane (CH₄) and VOCs that influence aerosol formation and radiative forcing. Overlooking ecosystem state and short-lived climate forcers can misestimate mitigation potential. Quantifying biodiversity–climate linkages is therefore critical to robustly evaluate net climate mitigation potential.

Knowledge Gap

We lack an integrated understanding of:

- How biodiversity and degradation alter GHG and VOC fluxes
- The relative climate importance of short-lived climate forcers vs CO₂
- How degraded systems shift from sink to source and thus net warming
- The contribution of bare sediments to radiative forcing



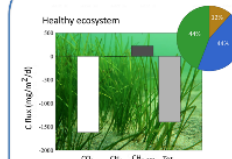
Degradation alters carbon burial, CH₄ emissions, and aerosol-forming VOC production, thus influencing net radiative forcing.

- Healthy systems: carbon burial dominates
- Degraded systems: elevated CH₄ and altered VOC fluxes
- Net climate effect depends on ecosystem integrity

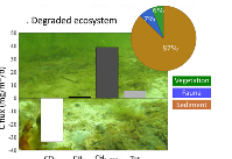
From Concept to Quantification

Methane offsets coastal CO₂ sinks, particularly in degraded systems.

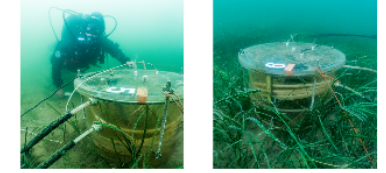
Healthy ecosystem



Degraded ecosystem



- Healthy habitats: CO₂ uptake dominates but is partially offset by CH₄.
- Degraded habitats: reduced uptake and elevated CH₄ shift climate balance



In situ heatwave experiments to explore realistic stressor effects on biodiversity and carbon cycling.

The CoastClim Super-Site Approach

We integrate marine ecology, biogeochemistry, and atmospheric science to quantify coastal climate feedbacks.

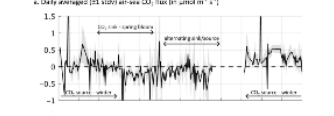
- High frequency GHG & VOC and aerosol fluxes
- Habitat comparisons (vegetated & bare sediments)
- Biodiversity quantification
- Long-term monitoring of seafloor and hydrography
- Stressor experiments (heatwaves, eutrophication)
- Aerosol formation pathway analysis
- Radiative forcing evaluation

If you are interested in joining – talk to us!

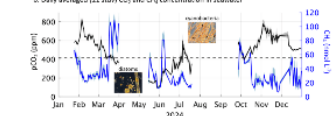
alf.norkko@helsinki.fi







Examples of high-resolution EC air-sea fluxes of CO₂ and CH₄



a. Daily averaged EC air-sea CO₂ flux (in $\mu\text{mol m}^{-2} \text{s}^{-1}$)




b. Daily averaged EC air-sea CH₄ concentration in seawater





Fin MARI
Finnish Marine Research Infrastructure

Ferry-induced waves in the Archipelago Sea

Authors: Josten Mariah¹, Forsblom Louise², Kankare Ville¹, Alho Petteri¹

Institutions: ¹University of Turku, ²Finnish Environment Institute

Research questions

1. How far from the fairway are ferry-induced waves detectable?
2. Which factors most strongly influence ferry-induced wave amplitude?

Observations of ferry-induced waves in the Archipelago Sea

Authors: Josten Mariah¹, Forsblom Louise², Kankare Ville¹, Alho Petteri¹
 Affiliations: ¹University of Turku, ²Finnish Environment Institute
 Contact Information: mariah.josten@utu.fi



Introduction



- Archipelago Sea has >50,000 islands, complex bathymetry, wind-driven currents, and frequent ferry traffic.
- Ship-induced waves can increase flow velocity, turbidity, and sediment resuspension.
- Ships generate low-frequency primary (displacement) waves and high-frequency secondary (surface) waves.
- The processes that amplify or dampen ship-induced waves in complex archipelago environments are poorly understood.

Research Questions

1. How far from the fairway are ferry-induced waves detectable?
2. Which factors most strongly influence the amplitude and energy of ferry-induced primary (displacement) waves?

Methods

1. **Process pressure data** to compute free surface elevation (η) and separate low-frequency primary waves and high-frequency secondary/wind waves.
2. **Estimate ferry wave arrival times** at field sites using interpolated AIS data.
3. **Define ferry event windows** using predicted arrival times and wave energy envelopes.
4. **Compute wave metrics**: max crest/trough, mean and peak energy density for event windows.
5. **Compile predictor variables for each event** (vessel properties, site characteristics, wind conditions)
6. **Model wave metrics using machine learning** (XGBoost with SHAP) to rank the influence of predictor variables on wave metrics.

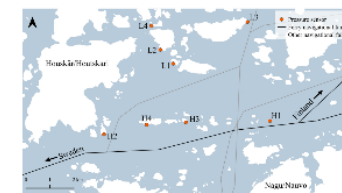


Figure 1. Pressure sensor site map

Results

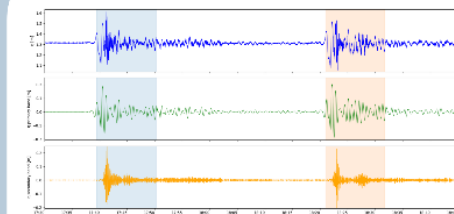


Figure 2. Site H1: Free surface elevation (η) and bandpass-filtered wave components (primary and secondary wave bands).

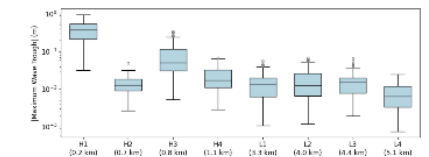


Figure 3. Absolute maximum wave troughs for single ferry events. Boxes show median and interquartile range; whiskers extend to 1.5x IQR, with outliers as points. Y-axis is logarithmic.

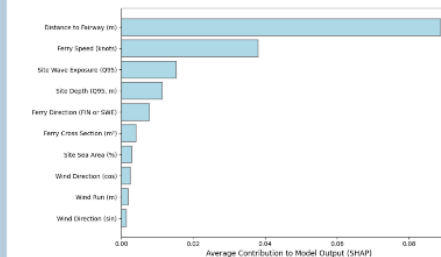


Figure 4. Maximum primary wave trough ranking using XGBoost. $R^2 = 0.934$, $RMSE = 0.042$, $MAE = 0.020$

Discussion

- Largest ferry waves occurred at H1 (0.2 km from fairway).
 - Max primary wave trough measured 1 m.
 - Baltic Princess and Viking Line generate the largest waves at 19–20 knots.
- Low-impact sites still show ferry signals, though amplitudes can be very small.
- Distance to fairway and ferry speed are the strongest predictors of max crest/trough.

Coastal environmental data – scattered and lost ?

Giannina Hattich, Sarah Rühmkorff, Lucinda Kraufvelin,
Sebastien Lafond, Tesfay Tesfay, [Christian Pansch](#)
Åbo Akademi University

- ✓ Frequency, intensity, & duration of marine heatwaves are increasing → biodiversity impacts
- ✓ Thermal stress does not occur uniformly across time and space → microclimates
- ✓ Coastal (temperature) data are needed, and are frequently collected, yet not centrally available
- ✓ **CoastSense** aims to provide easy and effective workflows for the scientific community to store and share coastal temperature data across Finland and the Baltic Sea

→ PROVIDE YOUR INPUT

Drivers of underwater biodiversity for targeting mitigation actions in a morphometrically complex archipelago

Lauri Kuismanen^{1,2}, Louise Forsblom³, Matias Scheinin², Christian Pansch¹

¹Åbo Akademi University, ²Turku University of Applied Sciences, ³Finnish Environment Institute

³Finnish Environment Institute

- ✓ **Poster:** Introduction, project plan, early exploratory analyses
- ✓ **Goal:** Environmental drivers of underwater biodiversity
- ✓ **Goal:** Evaluate monitoring adequacy
- ✓ **Utilising:** Velmu & Coastrider data

Drivers of underwater biodiversity for targeting mitigation actions in a morphometrically complex archipelago

Lauri Kuismanen^{1,2}, Louise Forsblom³, Matias Scheinin², Christian Pansch¹
¹Åbo Akademi University, ²Turku University of Applied Sciences, ³Finnish Environment Institute

Why?

- Biodiversity loss due to human activities and its subsequent effects
- Knowledge gap: spatiotemporal mismatch between biodiversity and water quality data
- Local, regional coastal zone management of areas requires high-resolution spatiotemporal biodiversity products to guide decision-making
- Ambitious objectives of the EU Nature Restoration Regulation

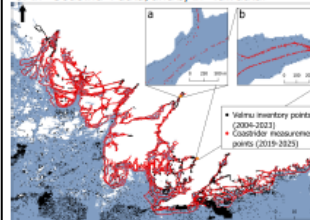
Project overarching goals

1. Determine how environmental drivers shape marine species distributions and community composition over space and time
2. Identify how well biodiversity is accounted for in marine monitoring, particularly in a morphologically complex system such as the Archipelago Sea

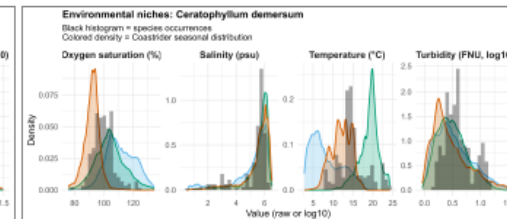
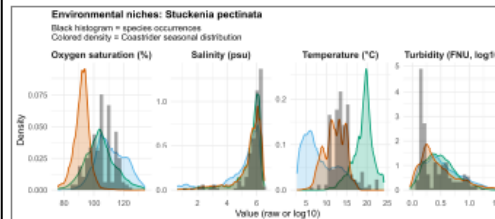
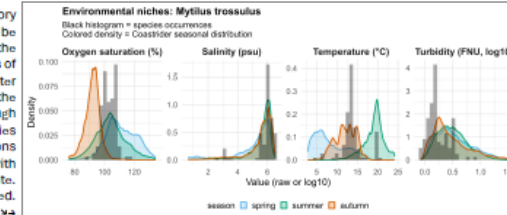
How, what data?

- Coastrider** – a mobile and continuous measurement platform for water quality data
- Total ~1,5 million high-resolution water quality measurements across key variables, spanning full ice-free seasons over several years
- Velmu** – the Finnish inventory programme for underwater marine biodiversity
- Marine biodiversity inventories, with over 60 000 spatially explicit sampling points in the Archipelago Sea alone

The study area, the Archipelago Sea and westernmost Gulf of Finland. Inset map a) shows only 20 % of the Coastrider data, and b) the full data.



Example exploratory analysis: the data can be utilised in exploring the environmental niches of species in relation to water quality measured by the Coastrider flowthrough system, where species observations approximately overlap with the Coastrider's route. Data are spatially coupled.



Acknowledgements

The Jenny and Antti Wihuri Foundation is thanked for financing the project. Lucinda Kraufvelin is thanked for species illustrations, and Jenny Wikström for Coastrider interpolation maps. FINMARI infrastructure has been utilised to collect the data used in this project.



Finlands miljöcentral
Finnish Environment Institute



Chapter	1	2	3
	Biodiversity patterns	Species tolerances	Monitoring adequacy
Input	Spatiotemporal high-resolution water quality data Species data	Spatiotemporal high-resolution water quality data Species data	Outputs from chapters 1, 2 VS. Existing biodiversity monitoring data
Analysis method	Community modelling: GLLVM, HMSC	Environmental niches: GLLVM, SCAM	Assessment of scale mismatch and gaps
Output	Biodiversity patterns, metrics, hotspots, temporal variation	Species sensitivity, vulnerability to change	Recommendations for improved monitoring design
Role, significance	The effect of environmental drivers on biodiversity quantified	Species responses to environmental drivers and tolerance thresholds	Better informed environmental decision-making, local restoration and mitigation actions

Responses of brackish-water plankton communities to Ocean Alkalinity Enhancement using mesocosms

Henna Yliluikki^{1,2}, Nicolas-Xavier Geilfus³ and Jonna Engström-Öst^{1,3}

¹Novia University of Applied Sciences

²University of Turku

³Tvärminne Zoological Station

- ✓ Ocean alkalinity enhancement (OAE)
 - ✓ A method to mitigate climate change and counteract acidification
- ✓ Eco-physiological responses of plankton community to OAE
 - ✓ Fatty acids of zooplankton and seston

Responses of brackish-water plankton communities to Ocean Alkalinity Enhancement using mesocosms

Henna Yliluikki^{1,2} Jonna Engström-Öst¹
¹Novia University of Applied Sciences
²University of Turku



Background and Aims

- Ocean alkalinity enhancement (OAE) is a marine carbon dioxide removal (mCDR) concept
 - Alkaline material is added to sea water, resulting in elevated alkalinity, known as the buffer capacity of water
- OAE has the potential to store atmospheric CO₂ in seawater to mitigate climate change. In addition, OAE can counteract ocean acidification, at least on a local level, and thus, improve the health of marine ecosystems (Albright et al. 2016).
- Effects of OAE on the eco-physiology of organisms in eutrophic brackish-water are studied little, but it is crucial knowledge when evaluating the use of OAE as a mCDR tool or to improve condition of sea water
- We conducted large-scale mesocosm experiment with brackish-water from the western Gulf of Finland to study:
 - Eco-physiological responses of OAE on plankton community
 - Carbon chemistry of water under OAE-treatment
- We focused on the quantity and quality of zooplankton community as they are a crucial link between primary producers and higher trophic levels in marine food web

Methods



Fig. 1 We used 12 mesocosm units.

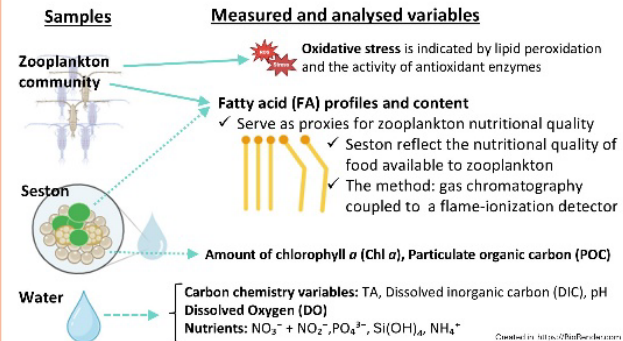
- 6-week experiment was conducted using 600 L indoor mesocosms (Fig. 1) at Tvärminne Zoological Station (TZS) in Hanko, Finland, during September–October 2025
- Mesocosms were filled with sea water from bay next to the TZS from the Gulf of Finland
 - ✓ Alkalinity (TA): ~ 1580 µmol/kg
 - ✓ Salinity: ~ 6 PSU
 - ✓ T: 15 °C (29.8.2025) throughout the experiment
- Natural plankton community
- Light: Dark - 16:8 h
- NO₃⁻ and PO₄³⁻ nutrients added twice a week

- Slaked lime, Ca(OH)₂ was used as OAE-material to artificially elevate TA of water
 - Low, increased 250 µmol/kg
 - High, increased 500 µmol/kg
- Four biological replicates for treatments and control

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References: Albright et al. (2016). Reversal of ocean acidification enhances net coral reef calcification, *Nature*, 531, 362-365.

Waldemar von Frenckells stiftelse



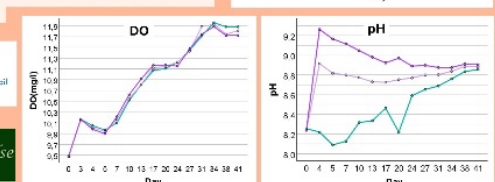
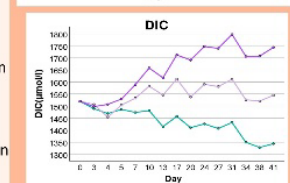
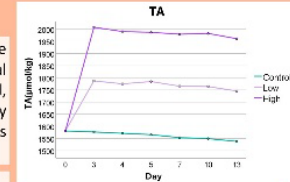
Preliminary Results

Hypothesis: coastal water conditions are improved through OAE and the nutritional quality of zooplankton food will be enhanced, leading to improved zooplankton physiology and a shift in their fatty acid profiles towards more unsaturated fatty acids.

• Sample analyses are still ongoing, so only preliminary results are presented.

• Ca(OH)₂ treatments have altered the carbon chemistry of water, increasing TA, pH, and DIC.

• The intensity of the treatments is reflected in these changes, with elevated TA leading to increased DIC



FinmariTech Group

Many Authors
across all FinMARI Institution

- ✓ Unique scientific expertise of each partner
- ✓ Specialized equipment & facilities
- ✓ Shared research themes
- ✓ Complementary methodologies

	Geology	Oceanography	Biology
Field	 FMI, GTK, Syke, TURUN YLIOPISTO	 FMI, GTK, Syke, TURUN YLIOPISTO	 FMI, Luke, Syke, TURUN YLIOPISTO
Experiments	 GTK	 FMI, GTK, Syke	 Luke, Syke, TURUN YLIOPISTO
Laboratory	 GTK, Syke	 Syke	 Syke, TURUN YLIOPISTO
Data	 FMI, GTK, Syke	 FMI, Syke, TURUN YLIOPISTO	 FMI, Syke, TURUN YLIOPISTO

Effects of Abiotic Factors and Diversity on the Ecosystem Functioning of Plankton Communities in the Baltic Sea

Authors: Sum Yi Lai¹, Sirpa Lehtinen², Veera Norros², and Jarno Vanhatalo¹

1. University of Helsinki

2. Finnish Environment Institute Syke



- ✓ How do abiotic factors and plankton taxonomic and functional diversity influence plankton resource use efficiency (RUE)?


	RUEpp	RUEzp
Taxonomic diversity pp	↑	↓
Functional diversity pp	↓	↑
Taxonomic diversity zp		↑
Functional diversity zp		↓
Cyanobacteria dominance	↑	↓

- ✓ Cyanobacteria dominance is a key driver of plankton productivity

- ✓ Need to consider the context-dependency of biodiversity-ecosystem functioning relationships



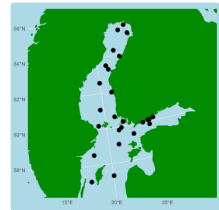

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Effects of Abiotic Factors and Diversity on the Ecosystem Functioning of Plankton Communities in the Baltic Sea

Sum Yi Lai, Sirpa Lehtinen, Veera Norros, and Jarno Vanhatalo
sum-yi.lai@helsinki.fi

1. BACKGROUND

Phytoplankton underpin marine ecosystems by driving primary production and fueling pelagic food webs. **Biodiversity** can enhance ecosystem functioning, but its effects are context-dependent and shaped by environmental conditions and species interactions. Both taxonomic and functional diversity influence **resource use efficiency (RUE)**, though their relative roles vary with nutrient regimes and trophic structure. In the **Baltic Sea**, warming and freshening are expected to favor cyanobacteria, reshape plankton communities, and alter trophic dynamics, with consequences for ecosystem functioning and food-web stability.

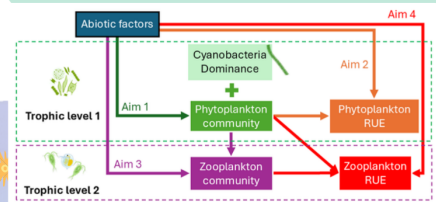


3. METHODS

We analyzed long-term (2000–2024) **Baltic Sea** monitoring data on phytoplankton and zooplankton communities. **Taxonomic and functional diversity (evenness (FEve) and dispersion (FDIs))** were calculated, and **cyanobacteria dominance** was defined as their relative abundance. **RUE** was estimated as log phytoplankton abundance per unit total phosphorus, and log zooplankton abundance per unit phytoplankton abundance. We fitted Bayesian multivariate regression models including seasonality (DOY) and random intercepts for depth, site, and year, classified response shapes (positive, negative, U-shaped, bell-shaped).

2. RESEARCH QUESTION

How do abiotic drivers and plankton diversity regulate RUE?



4. RESULTS

Explanatory Variables	Genus Richness	FEve	FDIs	Cyanobacteria Dominance	RUEpp
Temperature	↓	U	∩	n.s.	n.s.
Salinity	U	U	U	∩	U
pH	↑	∩	∩	↓	↑
Log N:P Ratio	n.s.	n.s.	U	↓	↑
DOY	∩	n.s.	n.s.	∩	∩
Genus Richness					↑
Phytoplankton FEve					↓
Phytoplankton FDIs					↓
Cyanobacteria Dominance					↑

Summary table (top) of the effects of abiotic and biotic factors on **phytoplankton diversity and RUE (Aim 1 and 2)**. Responses include positive ↑, negative ↓, U-shaped U, bell-shaped ∩, and non-significant (n.s.).

Explanatory Variables	Species Richness	FEve	FDIs	RUEzp
Temperature	n.s.	∩	n.s.	↑
Salinity	n.s.	n.s.	U	∩
pH	n.s.	∩	n.s.	↓
DOY	↑	n.s.	n.s.	↑
Phytoplankton Genus Richness	n.s.	n.s.	n.s.	↓
Phytoplankton Predation FEve	n.s.	n.s.	n.s.	↑
Phytoplankton Predation FDIs	n.s.	n.s.	n.s.	n.s.
Zooplankton Species Richness				↑
Zooplankton FEve				n.s.
Zooplankton FDIs				↓
Cyanobacteria Dominance	↑	↓	n.s.	↓

Summary table (right) of the effects of abiotic and biotic factors on **zooplankton diversity and RUE (Aim 3 and 4)**.

5. CONCLUSION

Our results show that biodiversity-ecosystem functioning relationships in the Baltic Sea are strongly context dependent, varying across biodiversity facets and trophic levels, with abiotic drivers producing complex and sometimes contrasting effects. Taxonomic and functional diversity often had opposing effects on RUE, while cyanobacteria dominance consistently emerged as a key driver of plankton diversity and productivity. Future warming and eutrophication are likely to amplify these effects, highlighting the importance of understanding how shifts in community composition, especially cyanobacteria dominance, shape ecosystem functioning.



SOFT sediment DRedging Impacts on marine carbon sINKs (SOFTDRINK)

Tom Jilbert¹, Laura Kaikkonen², Ville Nenonen¹,
Elina A. Virtanen²
¹University of Helsinki, ²Finnish Environment Institute

- ✓ Dredging is widespread in Finnish waters: >36,000 recreational sites, 42 commercial harbors, and ~20% of sea areas designated for wind farms
- ✓ Soft marine sediments store large amounts of organic carbon, but dredging can release it back to the water column
- ✓ SOFTDRINK is a 4-year Research Council of Finland project quantifying these dredging impacts on sediment carbon stocks
- ✓ WP1: Baseline carbon maps using predictive spatial modelling with data from >600 field locations across Finnish sea areas
- ✓ WP2: Net carbon loss quantified via biogeochemical analyses, incubation experiments, and vessel-mounted real-time CO₂ / CH₄ monitoring
- ✓ WP3: Future risk scenarios combining sea-use planning, state-transition simulation modelling, and climate change projections

SOFT sediment DRedging Impacts on marine carbon sINKs (SOFTDRINK)

Tom Jilbert¹, Laura Kaikkonen², Ville Nenonen¹, Elina A. Virtanen²

¹ University of Helsinki, Department of Geosciences and Geography, Helsinki, Finland
² Finnish Environment Institute (Nature Solutions, Marine Ecology), Helsinki, Finland

PROJECT AIMS

SOFTDRINK is a 4-year project funded by the Research Council of Finland to determine impacts of dredging on sediment carbon stocks in Finnish sea areas. The project employs a 3-tier structure (Fig. 1) in which baseline carbon stocks will be determined through field sampling and spatial predictive mapping (WP1), net carbon loss during dredging will be investigated through real-time monitoring of dredging events and mapping of affected areas (WP2) and sea use scenarios will be integrated with climate change projections to generate risk scenarios for future loss of carbon sink potential (WP3).

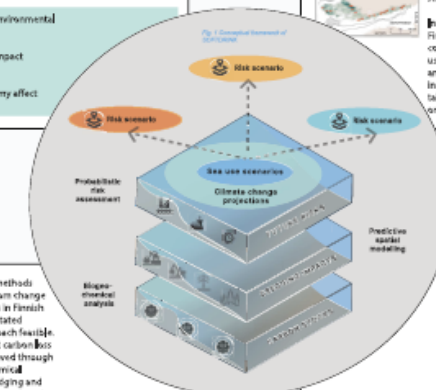
Guiding research questions

RQ1: How do sediment carbon dynamics relate to environmental gradients in complex coastal environments?
RQ2: How do human activities involving dredging impact sediment carbon dynamics?
RQ3: How will dredging associated with Blue Economy affect future carbon cycling under a warming climate?

APPROACH

In Finland, there are >36000 mapped locations of near-shore recreational land use dredging and 42 commercial harbours, as well as nearly 20% of sea areas designated for offshore wind farm (OWF) development (Fig. 2). SOFTDRINK will target these key activities to quantify the impacts of dredging on sediment carbon stocks. The project will make use of large available spatial datasets on sediment carbon, bathymetry and substrate to quantify baseline (WP1) and estimate current spatial impacts of dredging on sediment carbon stocks (WP2).

In close collaboration with partners in the Finnish Marine Spatial Planning (MSP) coordination group, we will develop sea use scenarios to predict dredging intensity and estimate impacts on sediment carbon in future (WP3). These estimates will take into account climate change impacts on seafloor carbon stocks.



METHODS

SOFTDRINK will employ a wide range of geospatial methods including quantifying the extent of dredged areas from change analysis of aerial images (Fig. 4). Many dredged areas in Finnish waters are found along vegetated shorelines making this approach feasible. In WP2, determination of net carbon loss from sediments will be achieved through a combination of biogeochemical analyses of sediments in dredging and dumping areas, incubation experiments (Wu et al., 2024) and real-time monitoring of CO₂ and CH₄ emissions using the small vessel-mounted Coastliner system (Arnell & Schwahn, 2024, Fig. 5). SOFTDRINK will use state-transition simulation modelling (Daniel et al., 2016) to visualize spatial impacts of dredging on carbon stocks.

DATA

At the core of the project is a predictive spatial model of baseline sediment carbon stocks in Finnish sea areas. A literature survey and data from project partners has yielded 3400 locations for which carbon stock in the uppermost 25cm of the sediment column can be estimated (Fig. 6). The power of environmental predictors such as depth-integrated wave exposure (Virtanen et al., 2019) to model carbon stock will be determined, and used in WP1 to create a baseline map similar to those from the North Sea (Diering et al., 2021) and Canadian continental margin (Epstein et al., 2024). This map will be used as the basis for state-transition simulation modelling of dredging impacts in WP2 and future scenario modelling in WP3.



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Resolving Wave Dynamics in Coastal Archipelagos

Laura Tuomi and Hedi Kanarik
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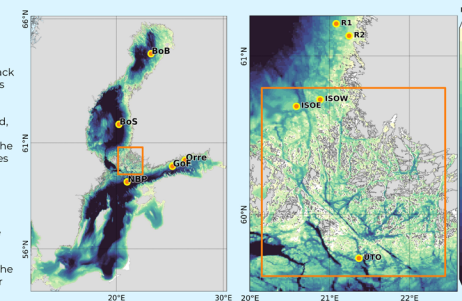
- FMI is developing coastal wave forecasting systems to better support safety of the maritime traffic in the coastal fairways.
- FINMARI infrastructure is important in getting measured data to calibrate and validate the forecast system.
- Demonstration of coastal wave forecast service available at marine.fmi.fi/aallokko

Resolving Wave Dynamics in Coastal Archipelagos

Laura Tuomi¹ and Hedi Kanarik¹
¹Finnish Meteorological Institute, Helsinki, Finland.

The Baltic Sea wave forecast and hindcast systems, such as those provided by the Copernicus Marine Service Baltic Sea Monitoring and Forecasting Centre (BAL MFC), often lack accuracy in predicting wave conditions in complex coastal areas, such as the Archipelago Sea, due to the relatively coarse resolution they use. Downscaled, high-resolution coastal systems are often needed to properly account for the effects of complex bathymetric features and dense archipelagos on the wave field.

New high-resolution coastal wave model systems have been developed for the Finnish coastal regions. We use the WAVEWATCH III® model with a seamless two-way nesting approach, employing a 1-nmi resolution grid for the entire Baltic Sea and 0.25-nmi grids for selected coastal areas.



Measured wave data is essential for calibrating and validating the wave model systems. Operational wave buoys are typically located in open-sea areas and therefore provide data that is mainly applicable to regional systems. Coastal wave measurements are generally scarce and available only at a few specific locations.

The FINMARI infrastructure enables us to carry out dedicated measurement campaigns to collect data from areas where the high-resolution coastal wave forecast systems are being developed.

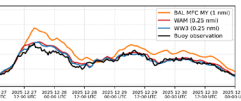
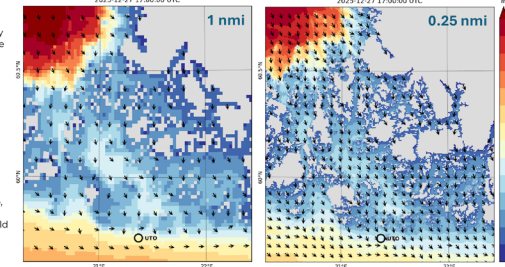
Bathymetry used in the 1 nmi wave model setup together with FMI operational wave buoys on the left and in the 0.25 nmi setup (with orange borders) with research wave buoys on the right.

Improved coastal forecast

The coarse resolution basin-scale grids, such as the BAL MFC products, are able to resolve the wave fields in the open sea areas with good accuracy. The grid-obstruction methods they use to account for the attenuation of wave energy caused by islands and islets smaller than the grid size, allow them to represent some of the features of the wave field in the archipelagos. However, these systems still tend to overestimate the significant wave height in near-coastal and archipelago areas especially during high wave events.

High-resolution wave model setups are able to capture the effects of complex bathymetry and dense archipelagos on the wave field. When compared with coastal wave measurements, such as those from the Uto wave buoy, they show a much better agreement with observations than the coarse-resolution grids.

In addition, high-resolution systems are capable of better describing for example, wave refraction on shoals and wave growth inside the archipelago, which leads to improved representation of the wave field characteristics.



Time series from a high-wave event in December 2025 from Uto research buoy significant wave height compared against 1 nmi forecast product (BAL MFC) and in Uto against two high resolution wave forecasts from Archipelago Sea region.

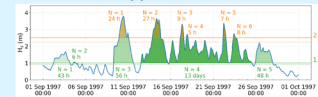
Significant wave height (colour) and principal wave direction (arrows) from 1 nmi BAL MFC multiyear (MY) product compared against 0.25 nmi WWS3 product and in Uto against two high resolution wave forecasts from Archipelago Sea region. Direction arrows are shown from every 5th grid point from 1 nmi product and every 10th grid point from 0.25 nmi forecast.

On demand high-resolution wave forecasts for piloting in coastal fairways

Due to the complex nature of the Finnish coastline, **no harbor is accessible to cargo ships without piloting**. Piloting includes risks for pilots especially when embarking and disembarking vessels, and piloting is typically paused in high sea states. To provide sufficiently accurate information about the wave conditions in these areas high resolution forecast systems are needed. However, due to the computational demands of these system they can be provided only on few coastal regions.

When the coarse resolution wave forecast indicates that the threshold will be exceeded within the next two days in the pilot boarding location or nearby areas the **on-demand 0.25 nmi resolution coastal wave forecast is activated**.

Event-based approach

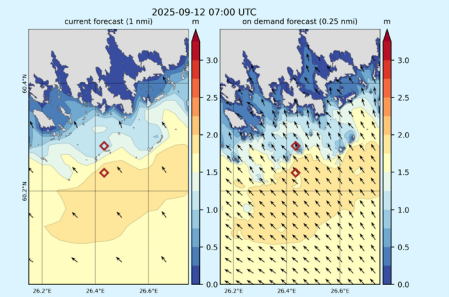


Example of an event-based approach for finding exceedances of a certain threshold from one model grid point. These checks are performed on all grid cells in the area of interest.

We have developed a system to identify occasions when the wave conditions are forecast to be potentially challenging or even dangerous for piloting. This allows us to run the high-resolution coastal forecasts only when they are actually needed.

We use information from the 9-day BAL MFC wave forecast available from the Copernicus Marine Service and event-based approach able to identify the areas from the model grid where the threshold is exceeded and calculate the duration of the event.

Area where SWH exceeded 1.7 m and duration of the event in the BAL MFC forecast 11 Sept 2025 00 UTC forecast.



Comparison of the on-demand wave forecast (right) at the Orengrund region to same forecast with 1 nmi resolution (left) on Sept 11 00 UTC. Red diamonds mark pilot boarding locations at the coastal fairway and arrows show wave direction at the spectral peak direction every 5th model grid point.

(Bio)geochemical Dynamics of Seawater-Aquifer Interactions: Impacts on Coastal Sediments and Ecosystem

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¹Department of Geology and Mineralogy, Åbo Akademi University

²Department of Environmental and Marine Biology, Åbo Akademi University

³Geological Survey of Finland, Marine Geology

Coastal **groundwater-seawater mixing** zones are important but poorly understood biogeochemical **hotspots**.

- Coastal mixing of groundwater and seawater drives **physical and biogeochemical** changes in sediments and aquifers.
- This project provides an interdisciplinary view of these dynamics along the SW Finnish coast.
 - How do these interactions shape **coastal aquifers**?
 - How do they influence **solute cycling** and **availability** in the marine environment?
 - What **responses** occur in benthic and pelagic communities?

Investigating links between ecosystem biodiversity and metabolism in shallow vegetated sites

Sarvesh P. Mundil¹, Tiina Salo¹, Camilla Gustafsson², Karl Attard³, Marie C. Nordström¹

¹Department of Environmental Sciences, University of Helsinki; ²Tvärminne Zoological Station, University of Helsinki; ³Nordcee, Department of Biology, University of Southern Denmark

- ✓ Coastal areas are regions with important ecosystem services and functioning, but they are facing several anthropogenic threats.
- ✓ Understanding the link between ecosystem processes and biodiversity helps us better understand these threats to these ecosystems
- ✓ Hence, this study aims to characterise links between ecosystem biodiversity and metabolism in shallow vegetated sites



Investigating links between ecosystem biodiversity and metabolism in shallow vegetated sites

Sarvesh P. Mundil¹, Tiina Salo¹, Camilla Gustafsson², Karl Attard³, Marie C. Nordström¹
¹Department of Environmental Sciences, University of Helsinki; ²Tvärminne Zoological Station, University of Helsinki; ³Nordcee, Department of Biology, University of Southern Denmark

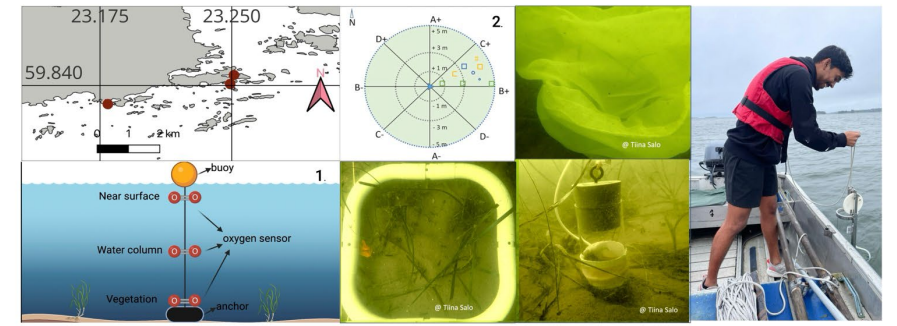


BACKGROUND AND AIM

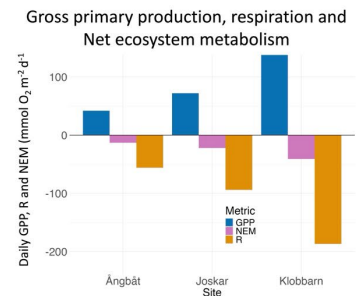
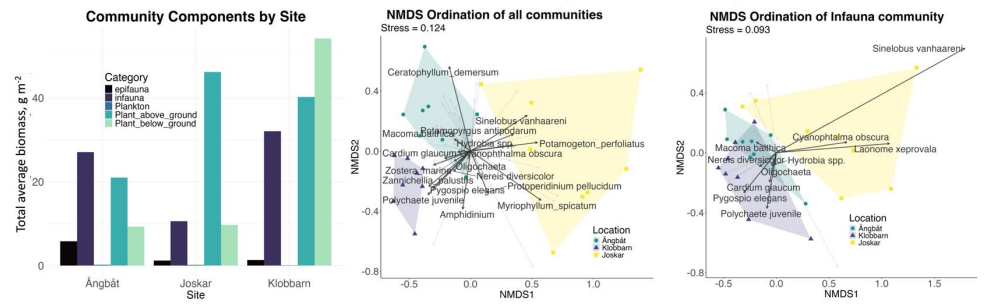
- Coastal zones are areas of high biodiversity and productivity, maintaining and providing multiple ecosystem processes, functions and services
 - These areas often experience high anthropogenic pressure, threatening coastal biodiversity
 - Understanding how biodiversity couples to ecosystem processes (such as metabolism) helps us better understand the threats to coastal ecosystem functioning and services.
- This study aims to characterize the links between community structure and composition and ecosystem metabolism in shallow vegetated sites.**

METHODS

We investigated three sites in the Tvärminne area, and quantified plant, plankton, epifauna and infauna communities. Oxygen fluxes were measured by placing O₂ sensors in situ at different depths from surface to bottom for 7-12 days.



PRELIMINARY RESULTS (BIOMASS BASED)



- Site community composition was significantly different across all sites ($p < 0.001$).
- Infauna composition differed only between Joskar-Klobbarn and Joskar-Ångbåt ($p = 0.002$ for both).
- Klobbarn had the highest average community biomass while Ångbåt had the lowest. Similar patterns were observed for the GPP, R and NEM.
- A potential link between the community biomass and community metabolism in soft-sediment shallow vegetated sites might be present

NEXT STEPS

Work is ongoing to determine the relative importance of individual ecosystem components, their biodiversity and biomass, as drivers of ecosystem metabolism

Funded by MARBEFS through the European Union under the Horizon Europe Program (HORIZON-CL6-2021-BIODIV-01; grant agreement no. 101060927). This work was undertaken using the facilities, services and resources of FINMARI (Finnish Marine Research Infrastructure consortium) and the European Marine Biological Resource Centre (EMBRIC-ERIC) at Tvärminne Zoological Station, University of Helsinki.
 1. Created using BioRender.com
 2. Rottli, J. F., Attard, K. M., Norkko, J., Clud, R. N. & Norkko, A. Towards a sampling design for characterizing habitat-specific benthic biodiversity related to oxygen flux dynamics using Aquatic Eddy Covariance. *PLoS ONE* 14, e0211673 (2019).

Carbon Dynamics of Degrading Filamentous Macroalgae in the Warming Baltic Sea: Preliminary Insights from a Mesocosm Experiment

Emilia Heiskanen-Dinsmore¹, Norman Göbeler¹, Aurora Menendez Garcia¹, Nicolas-Xavier Geilfus¹, Anna Villnäs¹, Joanna Norkko¹, & Alf Norkko¹

¹Tvärminne Zoological Station, University of Helsinki

- ✓ Filamentous macroalgae degradation
- ✓ Where does the carbon go?
- ✓ Mesocosm experiment
- ✓ Temperature linked to degradation rates and carbon fluxes (preliminary)

Carbon Dynamics of Degrading Filamentous Macroalgae in the Warming Baltic Sea: Preliminary Insights from a Mesocosm Experiment

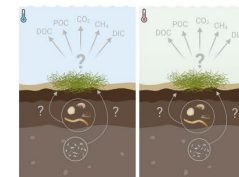
Emilia Heiskanen-Dinsmore¹, Norman Göbeler¹, Aurora Menendez Garcia¹, Nicolas-Xavier Geilfus¹, Anna Villnäs¹, Joanna Norkko¹, & Alf Norkko¹

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1. BACKGROUND

- **PROBLEM:** Legacy eutrophication has increased the overall production of filamentous macroalgal species in the Baltic Sea¹
- This results in large accumulations of organic matter degrading on the seafloor and shorelines¹
- Rising sea temperatures are predicted to accelerate the production of filamentous macroalgae and organic matter degradation
- Previous research indicates that this can enhance greenhouse gas (GHG) emissions from coastal systems^{2,3,4}
- **KNOWLEDGE GAP:** Where does the carbon go from degrading macroalgae?
 - The proportions of different carbon components released during degradation
 - How these might change under rapidly changing environmental conditions, such as marine heatwaves (MHWs)



AIM: Investigate the forms and proportions of carbon released during the degradation process of filamentous macroalgae *Cladophora glomerata* under a simulated MHW

2. EXPERIMENTAL SETUP

- 50-day mesocosm experiment at Tvärminne Zoological Station
- 2 x 2 experimental design: temperature (ambient, MHW) and biomass (algae, no algae; Fig. 1)
- Core-based incubations for flux measurements (Water column: DO, DOC, DIC, POC, TA, CH₄) at 9 time points
- Destructive sampling at 5 time points (Sediment: OM, Chl a, C:N, macrofauna, microbes; Algae: biomass, C:N)

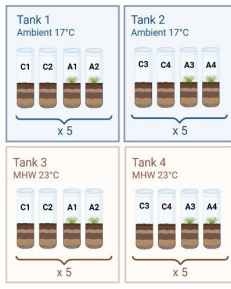


Fig. 1. Illustration showing the experimental design consisting of four temperature-controlled flow-through tanks and sediment cores (N = 80) for biomass treatments. The cores (N=80) were randomly divided across the four tanks, resulting in four replicate cores per treatment combination (replicate x temperature x biomass = 16) per time point.

3. PRELIMINARY RESULTS

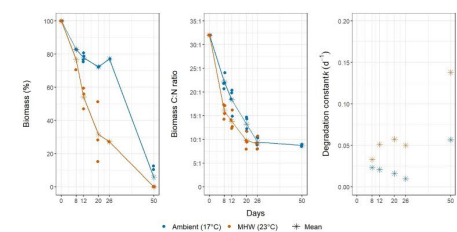


Fig. 2. Filamentous macroalgae *Cladophora glomerata* biomass characteristics recorded at baseline level (Day 0) and over the 50-day degradation experiment. (a) Relative biomass loss (%) was more rapid in the MHW treatment compared to the ambient treatment and was completely depleted by the end of the experiment (Day 50). (b) Biomass C:N ratio decreased during the experiment from an average of 32:1 (fresh algae) to <10:1 on average by the end of the experiment, indicating algal degradation over time. (c) Degradation constant *k* (d⁻¹) quantifying the rate of organic matter breakdown. Higher values indicate faster degradation, and lower values slower degradation, on average in MHW and ambient treatments, respectively.

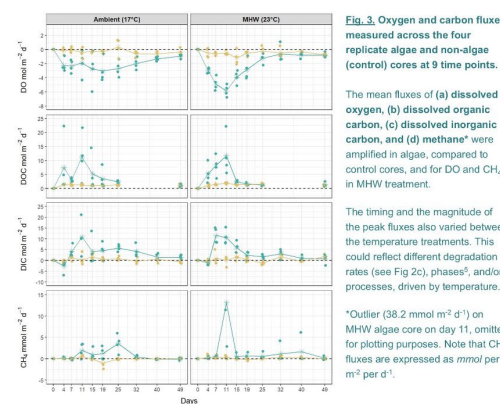


Fig. 3. Oxygen and carbon fluxes measured across the four replicate algae and non-algae (control) cores at 9 time points. The mean fluxes of (a) dissolved oxygen, (b) dissolved organic carbon, (c) dissolved inorganic carbon, and (d) methane* were amplified in algae, compared to control cores, and for DO and CH₄ in MHW treatment. The timing and the magnitude of the peak fluxes also varied between the temperature treatments. This could reflect different degradation rates (see Fig 2c), phases⁵, and/or processes, driven by temperature. *Outlier (38.2 mmol m⁻² d⁻¹) on MHW algae core on day 11, omitted for plotting purposes. Note that CH₄ fluxes are expressed as mmol per m² per d⁻¹.

Evaluating fish farms impact to a-chlorophyll

- Nea Matinlauri et al.
- In this research campaign we evaluated baltic sea fish farms impact to waterquality parameters such as a-chlorophyll
- We did not detected change in a-chlorophyll near farms, but more detailed data analysis are needed especially from debth.

Evaluating fish farms impact to a-chlorophyll

Nea Matinlauri, Markus Kankainen, Jari Niukko, Lauri Niskanen / Natural Resources Institute Finland (Luke)

Olli Malve, Jari Silander / Finnish environment institute (Syke)

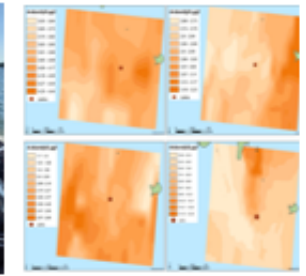
Different load at different conditions at different time

Fish farms impact on water quality in the Baltic sea has not been widely studied or published. In the Development Programme for Aquaculture, we launched a research campaign for the summer of 2025, where the goal was to gather data for impact models, that can be used further in license processes.

We committed seven three days research trips every three weeks starting from mid June so that last trip was in mid September. During these trips, we selected and visited six fish farms of varying production sizes, each located under different dispersion conditions in the middle and outer archipelago. In total, we conducted 70 site visits.

We evaluated chlorophyll-a and other values such as turbidity, from surface by directing the water to optical sampling tools while driving the boat around and between fish farms. We gathered and mapped using GPS the samples at 1 second interval to receive good amount of data from different distances from the farm. Quality of the data was validated with lab water samples.

Depth analysis were made with EXO9 sondes, funded with FIRI. For this analysis we made scannings 1. by the fish farms 2. 200 meters and 3. 400 meters from the farms, in each cardinal points. Meanwhile we measured current directions and strenght with drifters.



Hard to see the difference in water quality near farm

The hypothesis was that a-chlorophyll level near the farms would be higher. We gathered approx. 1 million samples from surface and different depths, near and further from farms and did not see clearly this impact. On contrary first statistic analysis showed that further than 1500, up to 3000 meters from farms, levels were higher. Further analysis may show better, whether this observation is based on nutrient load from fish farms.

Depth analysis showed that chlorophyll-a levels are on some occasions alot higher below surface. This observation was however made also in our control location, where there were no fish farms nearby, and elsewhere in water columns; In conclusion, in this in depth "fish farm impact assessment" further data analysis is needed.

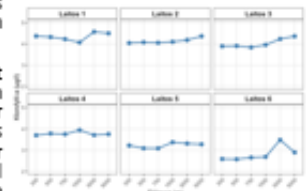
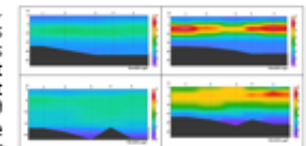


Figure 1. Tieto and Hawk Water sampling system while taking surface samples 1 per second 20m/s/h

Figure 2. Interpolated chlorophyll-a values around example (Laitas 1) fish farm

Figure 3. EXO 9 sond for depth scanning

Figure 4. South-North chlorophyll-a variation in depth in 16.6, 21.7, 25.8 and 11.9. Farm locates 16.6

Figure 5. Chlorophyll-a averages at different distances from the farms

One of the case farms is the largest in production volume in the Baltic Sea Finland, producing approximately 1,000,000 kilograms of rainbow trout



Ship wakes reduce *Fucus* recruitment

¹Petra Saari, ¹Dimitrios Kampantais, ²Veijo Jormalainen,

³Saija Saarni, ³Petteri Alho, ¹Christoffer Boström

¹Åbo Akademi University, Environmental and Marine Biology

²University of Turku, Department of Biology

³University of Turku, Department of Geography and Geology

- Impacts of ship wakes on reproduction of *Fucus vesiculosus*
- Investment in reproductive structures and gamete production were not affected by ship wakes
- Recruitment success was reduced near the fairway
- Impact sites experienced more frequent large waves, higher sedimentation rates, and lower light levels, which likely explain the reduced recruitment.

Using Satellite Data to Assess Sensitive Habitats and the Pressure They Face

Finnish Environment Institute (Syke), Ms Eeva Bruun, , Dr Jenni Attila , Dr Olli Malve , Dr Elina Miettunen Mr Janne Mäyrä, Mr Mikko Kervinen, Mr Eero Alkio , Mr Tomi Heilala
Natural Resources Institute Finland (Luke), Mr Lauri Niskanen, Mr Markus Kankainen , Mr Mika Laakkonen, Mr Jari Niukko
Finnish Meteorological Institute (FMI). Dr Aleksi Nummelin , Dr Antti Westerlund

- ✓ Satellite data provides efficient monitoring of sensitive marine habitats across large areas.
- ✓ Fish farming impacts can be detected using EO-based turbidity and chlorophyll indicators.
- ✓ Marine heatwaves are mapped reliably by combining high-resolution Landsat temperatures with daily SLSTR data.
- ✓ Small vessel detection from Sentinel-2 offers a new way to quantify human pressure on Natura 2000 sites.
- ✓ Field data and models support validation, using flow-through measurements, lab samples, and the FICOS nutrient model to understand changes under varying conditions.

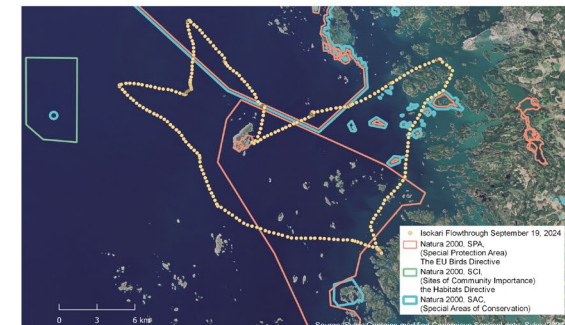


Figure 1. Flowthrough measurements, Sentinel-2 data and Natura 2000 areas in Isokari region in the coastal Finland at the Baltic sea. Measurements are done around a planned fish farm.

The Natura 2000 protected areas network

- Protected areas covering Europe's most valuable and threatened species and habitats.
- The largest coordinated network of protected areas in the world.
- Extending across all 27 EU Member States, both on land and at sea.
- Designated under the Birds and the Habitats Directives.
- In Finland there are 1866 Natura 2000 areas, and they cover around 50000 km². (European Environment Agency)

Using Satellite Data to Assess Sensitive Habitats and the Pressures They Face

Satellite observations can reliably assess the state of the environment, its temporal and spatial variations, and the characteristics of marine areas. In this study we assess the usefulness of earth observations (EO) for evaluating the impacts of fish farming, and marine heat waves on marine habitats in the coastal waters of Finland (Baltic Sea). For describing eutrophication, we use EO-derived chlorophyll-a and turbidity. For marine heat waves, we use multi-resolution approach of sea surface temperatures (Fig 2).

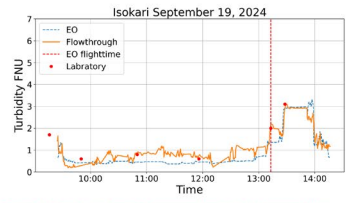


Figure 4. EO turbidity shows good correspondence with field measured flow-through data (yellow line in Fig 1) accompanied with water samples (analysed in laboratory).

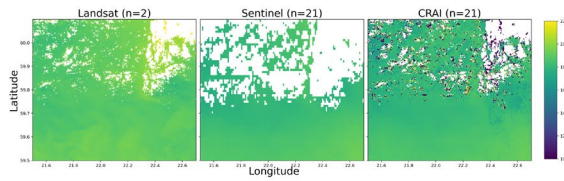


Figure 2. We analyse the benefits of sea surface temperature (SST) observations in monitoring extreme temperatures and heatwaves in sensitive habitats. We apply multi-resolution approach with 18m and 100m observations. Sentinel-3A-B SLSTR and Landsat-8/9 TIRS and TIRS-2, respectively. TIRSs, with 100m resolution, are advantageous in shallow and fragmented coastal areas, but have the shortcoming of sparse availability of observations. In contrast, SLSTRs observe daily. FMI utilized U-net architecture implemented in Climate Reconstruction AI (CRAI; Kadow et al. 2020) to fill in SLSTR observations near the coast by learning from TIRS observations. Some challenges remain as the results tend to be noisy on the points adjacent to the coast. The figure shows 2018-2024 average for near cloud free conditions for the month of August (number of images is quoted in parentheses).

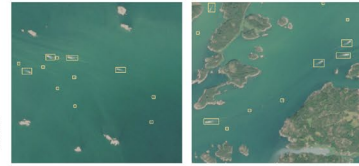
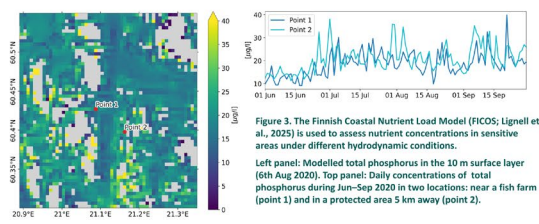


Figure 5. Syke has developed method to identify small vessels from Sentinel-2 MSI observations. It will be used to assess the pressure of small vessels exert on Natura 2000 areas annually (Mäyrä et al. 2025).



Left panel: Modelled total phosphorus in the 10 m surface layer (6th Aug 2020). Top panel: Daily concentrations of total phosphorus during Jun-Sep 2020 in two locations: near a fish farm (point 1) and in a protected area 5 km away (point 2).

Next, we will explore the Very high resolution (VHR) satellite data. Use of VHR images is especially advantageous near the shoreline, where the shortcomings of present open-source data with 10-20 m data exist. The cost-benefits and reliability of the information obtained through satellite observations are evaluated.

SALUPA project (2024-2025) is a collaboration between the Finnish Environment Institute (Syke), the Natural Resources Institute Finland (Luke), and the Finnish Meteorological Institute (FMI). It is funded by the European Maritime, Fisheries and Aquaculture Fund (EMFAF). We thank project Kalavalto for valuable field observations.

CRAI code: <https://github.com/FREVA-CLINT/climate-reconstruction/>
 European Environment Agency: <https://www.eea.europa.eu/themes/biodiversity/natura-2000/the-natura-2000-protected-areas-network/>
 Kadow, C., Hall, D.M., & Litvinch, U. Artificial intelligence reconstructs missing climate information. Nat. Geosci. 13, 408–413 (2020). <https://doi.org/10.1038/s41561-020-0682-5>
 Lignell, M., Miettunen, H., Kusan, R., Pöyry, T., Tuomi, P., Pihonen, L., Lukkar, K., Korppoo, H., Hultunen, R., Kuitila, V., Vanhatalo, and Thengstad (2025). Modeling new eutrophication in northern Baltic coastal zone is driven by new nutrient inputs, internal loading, and 3D hydrodynamics. Journal of Marine Systems, 249: 104549. <https://doi.org/10.1016/j.jmarsys.2025.104549>
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MARINE BIODIVERSITY UNDER CLIMATE CHANGE - NATURE-BASED SOLUTIONS AND LOCAL CUMULATIVE IMPACTS

Riikka Puntila-Dodd et al.
Åbo Akademi/Syke

- ✓ The marine environment experiences multiple, often cumulative pressures
- ✓ NBS have potential for alleviation of impacts
- ✓ Modelling tools have been limited
- ✓ Ecosystem modelling provides opportunities for evaluating the impacts of individual and cumulative pressures
- ✓ NBS can be effective in protecting some species, but curbing CC is the key

Riikka Puntila-Dodd (SYKE, ÅAU), Marta Coll (ICM-CSIC), Maria Bas (ICM-CSIC), Xavier Corrales (AZTI), Miquel Ortega (ICM-CSIC), Maciej T. Tomczak (SLU), Jeroen Steenbeek (EII), Dorota Szalaj (IPMA), Christopher Lynam (CEFA5), Åbo Akademi University, Environmental and Marine Biology, Henriksgatan 2, 20500 Åbo, Finland, riikka.puntila@abo.fi

INTRODUCTION

Marine ecosystems are under serious cumulative stress due to global climate change and various local pressures. **Nature-based solutions (NBS)**, such as restoration, spatial protection (e.g., MPAs), nutrient reduction, and **Nature Inclusive (Fisheries) Harvesting (NIH)**, can be used to alleviate the impacts. **Marine Ecosystem Models (MEM's)** provide a tool for exploring the outcomes of cumulative impacts and tradeoffs with various management interventions.

Future projections for European Sea ecosystems were modeled under three contrasting narratives: **Global Sustainability (GS)**, **National Enterprise (NE)**, and **World Markets (WM)**. Furthermore, cumulative impacts of shipping and offshore wind (OWF) energy production were modeled in two contrasting scenarios (GS and NE).

METHODS

The **Ecosystem Models (Ecopath with Ecosim)** built and calibrated for the **Western Mediterranean Sea, North Sea, Central Baltic Sea, Archipelago Sea, Bay of Biscay, and Portuguese Shelf** were used. Future changes in abiotic parameters and primary production were modeled using biogeochemical models under **RCP 4.5 and 8.5**. In the Baltic Sea, two nutrient emission scenarios (REF and BSAP) were also used. The spatial-temporal layers were used to drive the ecosystem models. Future spatial protection (MPA) scenarios were designed from available local plans to fulfill the **30 by 30** in the Global Sustainability scenario. **Offshore Wind Farm** locations (current and future) and shipping intensity were extracted from EMODNET. **Response functions** for the environmental parameters, habitat affinity, and responses towards wind farms and shipping were extracted with an extensive literature review. At this preliminary stage, impacts were limited to **direct impacts to habitat increase or destruction** (selected benthic organisms), **foraging** (avoidance of either shipping lanes or OWF by mammals or birds), and **direct mortality due to collision** (birds; OWF or mammals and turtles; shipping).

RESULTS - NBS

Many of the results are driven by the **climate change and nutrient reduction scenarios**. However, the fate of the heavily fished species can be changed with **sustainably managed fishing** (effort reduction and MPAs). Key conservation species show drastic differences between the scenarios.

OWF & SHIPPING

Changes due to shipping and OWF are related to 1) **direct mortality** to certain groups (birds, mammals) and 2) **restrictions on fishing** in these areas.

Shipping impacts are **spatially localized** to regions with a high density of shipping routes. Impacts **do not propagate widely** through the ecosystem. Greatest **negative impact** on mammals, reptiles, and some key fish species. Modelled reduction of marine shipping traffic does reduce impacts.

Wind farm impacts are spatially localized (e.g., increased mortality among birds). De facto MPA has a more significant impact.

CUMULATIVE IMPACTS

Cumulative impacts of local pressures are **alleviated in the GS scenario** compared to the NE scenario. **Trade-off** with added spatial protection and fishery catches.

CONCLUSIONS

NBS have the **potential to buffer** the impacts of climate change for **some species**. The **impacts** become more pronounced towards the end of the century.

OWFs result in **local decreases** in birds, but these are **offset by spatial protection**. Impacts are negated by the **overwhelming impact of climate change**.

Increases in **marine traffic** and **climate change** without mitigation lead to **reductions in mammal populations** in some regions.

Mitigation measures for shipping may play a crucial role in protecting marine mammals and turtles. Managing climate change would have the **largest effect**.

Marine Research Laboratory

Anne-Mari Luhtanen
Finnish Environment Institute (Syke)

- ✓ Information about Syke's Marine Research Laboratory in Viikki
- ✓ Expertise and facilities
- ✓ Analyses
- ✓ Equipment for field work



syke.fi | ymparisto.fi



Photo: Ilkka Lastumäki, Syke

Baltic Sea monitoring and marine research

The Marine Research Laboratory at Syke produces analyses and measurements for the Baltic Sea monitoring programme. The monitoring programme is part of the European Union's common maritime policy. Laboratory also provides expert personnel, facilities, and equipment for marine research needs.



Marine Research Laboratory

Viikki, Helsinki

The Marine Research Laboratory of the Finnish Environment Institute (Syke) is part of the national marine research infrastructure FINMARI. The laboratory offers analysis and research services to Syke researchers and partners. Through national and international research infrastructure projects, other entities can also apply for laboratory time for research.

Expertise and facilities

The skilled and experienced staff of the Marine Research Laboratory are the foundation of all operations.

Expertise (Baltic Sea):

- Phytoplankton (also cultivation)
- Zooplankton
- Benthic animals
- Nutrient analyses (NO₂, NO₂+3, TOTN, NH₄, PO₄, TDIP, SiO₄)
- Hydrographic analyses (pH, alkalinity, oxygen, hydrogen sulfide)
- Chl-*a*
- Carbon cycling + nitrogen (DIC, DOCN, TOC/N, POC/N, TPC)
- Microplastics
- Bio-optics, particle analysis and imaging

Facilities

- Molecular biology laboratory
- Isotope laboratory
- Microplastics laboratory
- Indoor mesocosm facilities
- Temperature and light controlled cold rooms for experimental research
- Microscopy facilities

Field work

Marine Research Laboratory has up-to-date equipment for marine field work, e.g.:

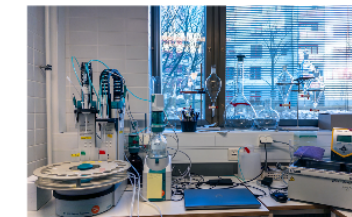
- Benthic lander
- Various in-situ sensors especially for biogeochemical and optical studies
- Imaging Flow Cytobot, CytoSense and FlowCam imaging instruments for plankton research
- AquaBox automated multichannel and multiparameter sampling and measurement unit
- Sediment traps
- Octonaut transportable outdoor cabin for instruments
- Breidel large volume hose pump (10512 L/h)
- Laboratory and sampling marine containers

Other resources

- Microalgae culture collection
- Sampling requests from Aranda monitoring cruises and Alg@line Ferryboxes



Syke's Marine Research Laboratory is a FINAS-accredited laboratory. The operations meet the requirements of the standard SFS-EN ISO/IEC 17025: FINAS 1005.



Automatic filtrator for alkalinity and oxygen. Photo: Ilkka Lastumäki



CytoSense scanning and imaging flow cytometer. Photo: Ilkka Lastumäki



QR code: more information about Marine Research Laboratory in Syke

Contact: Anne-Mari Luhtanen, anne-mari.luhtanen@syke.fi

User agreement to work in FINMARI facilities

FINMARI Management Group

- ✓ You must fill in new form before using any FINMARI facilities.
- ✓ The form helps us organize access to labs, instruments, and technical support so everything runs smoothly.
- ✓ We also need this information for reporting to the Research Council of Finland and European research infrastructures.
- ✓ All FINMARI partners will start using similar form in 2026 except Tvärminne and Seili

Access application / user agreement:
FINMARI Marine Research Infrastructure
facilities


Syke Marine research laboratory, RV Aranda, Utö research station & field equipment

Please, complete this booking form to ensure the availability of services and facilities for your project.

Liity skannaamalla
QR-koodi tai
käyttämällä linkkiä



<https://forms.office.com/e/PGUxvE6W6w>

 Kopioi linkki



FINMARI at GTK

Aarno Kotilainen & Joonas Virtasalo
Geological Survey of Finland (GTK)

- ✓ In our poster, we present GTK's main marine geological research infra
- ✓ Do get in contact for access and collaboration

Rock rules Collect once – use many times

Geological Survey of Finland (GTK) – Marine Geology



- Research vessel Geomari**
Length 20 m, width 7.6 m, draught 0.8 m, volume 7 x 2 m, 8 x 2 x 1 m, 11 m, 12 m, 13 m, 14 m, 15 m, 16 m, 17 m, 18 m, 19 m, 20 m, 21 m, 22 m, 23 m, 24 m, 25 m, 26 m, 27 m, 28 m, 29 m, 30 m, 31 m, 32 m, 33 m, 34 m, 35 m, 36 m, 37 m, 38 m, 39 m, 40 m, 41 m, 42 m, 43 m, 44 m, 45 m, 46 m, 47 m, 48 m, 49 m, 50 m, 51 m, 52 m, 53 m, 54 m, 55 m, 56 m, 57 m, 58 m, 59 m, 60 m, 61 m, 62 m, 63 m, 64 m, 65 m, 66 m, 67 m, 68 m, 69 m, 70 m, 71 m, 72 m, 73 m, 74 m, 75 m, 76 m, 77 m, 78 m, 79 m, 80 m, 81 m, 82 m, 83 m, 84 m, 85 m, 86 m, 87 m, 88 m, 89 m, 90 m, 91 m, 92 m, 93 m, 94 m, 95 m, 96 m, 97 m, 98 m, 99 m, 100 m
- Research boat Grif**
Length 6.0 m, width 2.2 m, draught 0.5 m, crew 2, 3 persons, total speed 20 knots, and cruise speed 7 knots
- Gemax corer**
For undisturbed soft sediment sampling
- Benthic lander**
Instruments for measuring suspended particle transport and changes in shallow morphology. First measurements (2007-2008) included particle size distribution and concentration, Turbidity, Deposition frequency of bedload over 400-700 cm and mid-depth suspension, velocity, direction, depth, turbidity, particle profile measurements. These have been used to study the effects of deposition on the seabed and to study the effects of deposition on the seabed.
- Vibro hammer corer**
This corer has been designed for sampling soft to medium hard sediments in shallow waters such as grass, and boulder-free areas.
- Swath sonar**
Multi-beam echo sounder system for mapping seafloor bathymetry and morphology. It can provide high-resolution data on seabed substrate and morphology. See background image.
- Free-Fall Cone Penetrometer**
Measurement of cone resistance and shear strength of soft sediments.
- FloatEM**
A novel magnetic electromagnetic induction (EMI) system for measuring conductivity (resistivity) of the seabed.
- Sound Velocity Profiling**
Automated measurement of sound velocity and temperature profile from a mooring vessel.
- Side-scan sonar**
Side-scan sonar imaging provides information on seabed roughness, substrate and topography and is essential for mapping the seabed.
- Sub-bottom profiling**
Sub-bottom profiling provides a continuous picture, profile, of the seabed.

The background shows submarine linear dunes in the Bothnian Bay. The image is produced using a multibeam sonar.



Services for Marine research

Authors: Jari Hänninen & Katja Mäkinen

Institution: Archipelago Research Institute, Seili

- ✓ Please, check options Seili field station can offer for your marine research. Come to see our poster for details and connections.

SERVICES FOR MARINE RESEARCH



UNIVERSITY OF TURKU | Biodiversity

ARCHIPELAGO RESEARCH INSTITUTE
TURKU ARCHIPELAGO - SEILI



ARI The *Archipelago Research Institute* of Turku University, located at the Seili island, has been established in a former 18th century asylum, which has been converted into a modern state-of-the-art international marine research facility. The neoclassically built environment provides an ideal, inspiring and unique framework for conducting high quality marine research. SITES.UTU.FI/SEILI/

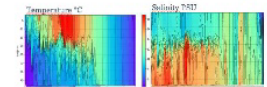


EMBRC Besides FINMARI, the services offered at ARI are also part of the *European Marine Biological Resource Centre*, which provides access to marine ecosystems and experimental platforms, and related services, to researchers from both academia and industry. WWW.EMBRC.EU



ENVIRONMENTAL MONITORING

- As a part of global ODAS network, ARI provide sixty-year-long environmental time series of seawater temperature (°C) and salinity (PSU), and meso-zooplankton community composition from 0-45 deep water column from institute's fixed monitoring station north of Seili island.
- Since the early 1980s, ARI has also monitored the characteristics of the spawning herring population in the Archipelago Sea as part of a long-term project on herring reproductive biology.
- Downloadable automatic seawater measurements from Seili automatic profiling buoy, with weather station and eutrophication predictions for the next 10 days, to complement the manual measurements for higher sampling frequency and real-time data acquisition (SAARISTOMERI.UTU.FI/ODAS_FI/)



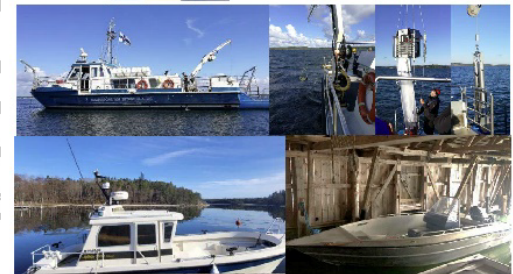
VESSELS, equipped a range of samplers/probes for field studies (e.g. Nets, Grabbers, Sonars, ROVs, etc.)

r/v Aurelia

- Max. capacity 40 persons (+ 2 crew; the vessel is hired only with crew)
- Overall length 18.1m, beam 5m, draft 1.5m, max. speed 15 knots, gross tonnage 5.8 t.
- Outdoor working space (16.4 m²), Lowered sampling deck (15.5m², small laboratory/wet lab space (2.9 m²))

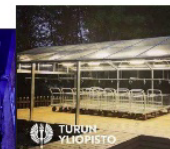
Minor Range 7600 & Faster 515 motor boats, available for transportations and sampling trips in the Archipelago Sea

- Max. 6-8 passengers
- Lengths 5.1-7.5 m
- Powers 60-160 hp



EXPERIMENTAL FACILITIES

- Three drylabs and four wetlabs, classrooms, cold facilities, superfreezers (-80°C), etc.
- Ten indoor experimental racks with nine 10-30 litre aquaria tanks each with temperature-controlled flow-through seawater and adjustable light periods and spectra
- Outdoor flow-thru mesocosms with 16 units tanks (120 litre), equipped with wave machines if needed



For more information of our possibilities, see SITES.UTU.FI/SEILI/

Services for Marine Research at Tvärminne – where to next?

- ✓ The “Tvärminne Hub” to integrate research, scientific diving, science education and outreach
- ✓ Come and check out the current “architect’s vision”. What would you like to see in there?



SERVICES FOR MARINE RESEARCH

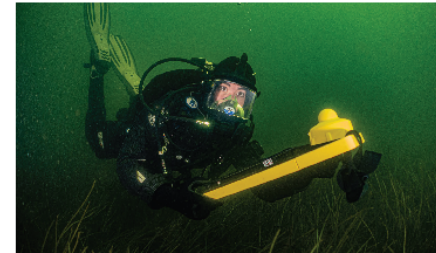


Over 120 years of Baltic Sea research, now focusing on the links between coastal biodiversity, ecosystem functioning and climate change. Our competent staff has experience on various instrument deployments and experimental setups both in the field and in the laboratory. We are happy to help you from the planning to the execution. TZS offers in-house lodging and catering facilities for visiting researchers. The sauna is very popular!

EMBRC The services offered at TZS are part of the European Marine Biological Resource Centre, which provides access to marine ecosystems and experimental platforms, and related services, to researchers from both academia and industry. WWW.EMBRC.EU

SCIENTIFIC DIVING

Sampling and instrument deployment; supported by the Finnish Scientific Diving Academy specialising in advanced training and support for underwater research.



ECOSYSTEM ACCESS AND FIELD EXPERIMENTS

- Access to a range of habitats from inner to outer archipelago and outer sea within an MPA managed by the station
- Research vessels of different sizes: R/V Augusta (18 m catamaran), hovercraft for winter sampling, and a range of smaller boats for coastal sampling also suitable for diving operations
- Standard sampling equipment such as water samplers, plankton nets, sediment corers and grabs, and handheld probes (CTD, oxygen)

LABORATORY SERVICES

- Water chemistry (e.g., nutrients, chlorophyll, carbonate system) and sediment analyses
- Molecular biology laboratory facilities
- Stereomicroscopes, upright and inverted microscopes fitted with cameras, some with fluorescence capability

HELSINKI.FI/TVARMINNE

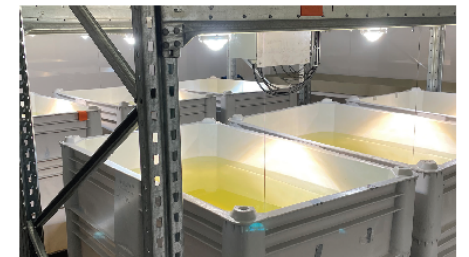


ENVIRONMENTAL MONITORING

- Unique, over hundred-year-long datasets of biological and hydrographical parameters
- Automatic measurements to complement the manual measurements for higher sampling frequency and real-time data acquisition (www.helsinki.fi/monicost)
- Part of the European Marine Omics Biodiversity Observation Network (EMOBON), sampling water column, soft substrates, and hard substrates
- ICOS station for atmospheric and oceanic greenhouse gas measurements

EXPERIMENTAL FACILITIES

- Experimental tanks in temperature-controlled rooms from 10 litre aquaria to 12 x 600 litre tanks, with flow-through seawater and adjustable light spectra
- Can be fitted with automated sensors (temp, cond, oxygen)
- Outdoor mesocosms of up to 5 m³ volume, with 12 units (flexible plastic bags) attached to a floating raft



FINMARI PHYTOPLANKTON CULTURE COLLECTION

- Approx. 100 species strains of Baltic Sea phytoplankton, cultivated at +4 °C and +16 °C, salinity 6
- For ecological and applied research, instrument testing, harmonization of methods and education