High resolution coastal ocean model of Galway Bay, Ireland, supporting oyster aquaculture and biodiversity restoration.

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Outline

Motivation

Galway Bay, stakeholders needs, project consortium

Galway Bay Model

Model extent and forcing, Copernicus products used

NAUI service

An online platform providing services to the end users

Downstream services

Mapping marine conditions & low salinity warning

Ocean Predict

In partnership with

unesco Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

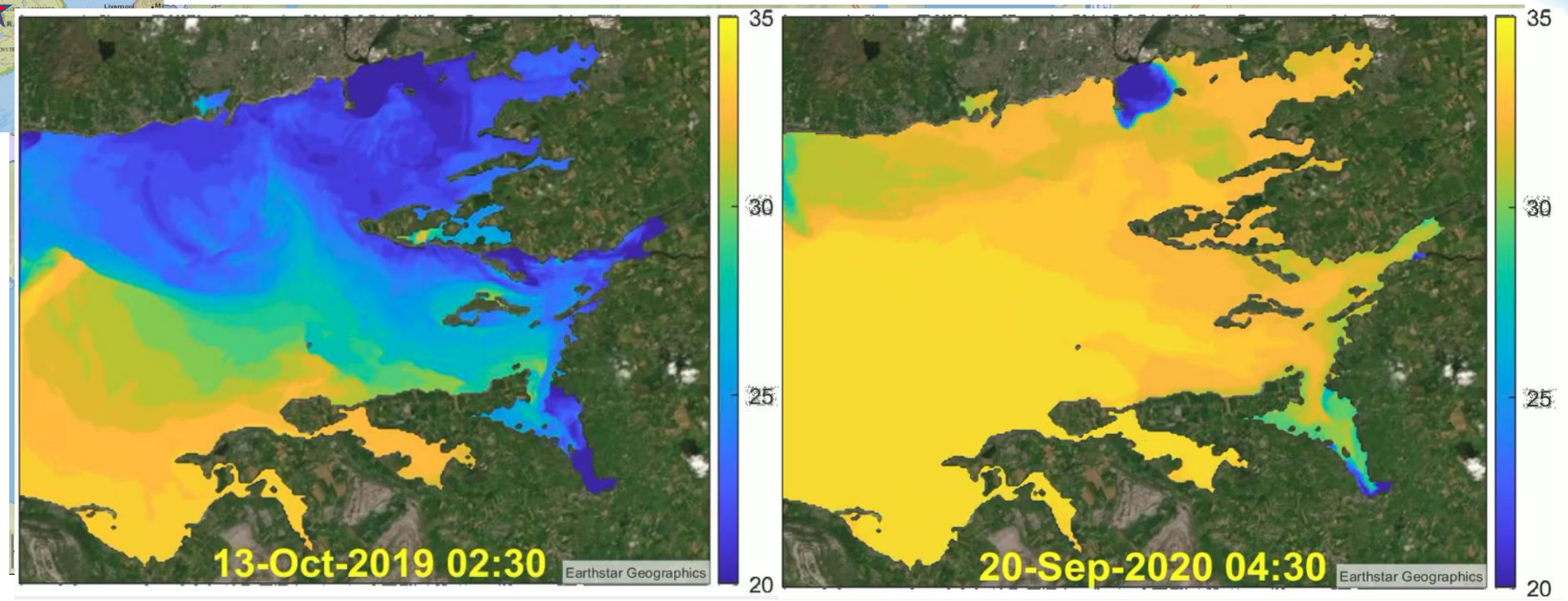
Marine Institute Foras na Mara

now Systems

Copernicus Marine Service User Engagement Programme 2022-2028

Galway Bay

Salinity distribution in Galway Bay



Stakeholders needs

The service aims to support:

- sustainable mariculture
- biodiversity restoration
- informs policy and supports policy implementation

Stakeholders involved in co-development:

- Cuan Beo (an environmental NGO)
- Oyster farmers
- Environmental Protection Agency (WFD monitoring, OSPAR)

Two Use Cases:

- mapping marine conditions (example Fig. 1)
- low salinity warning (example Fig. 2)

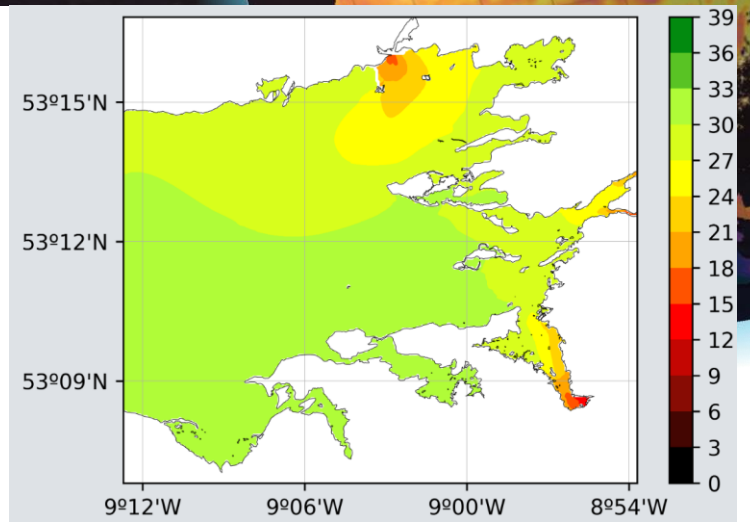


Fig. 1. Long-term (2012 – 2022) average surface salinity.

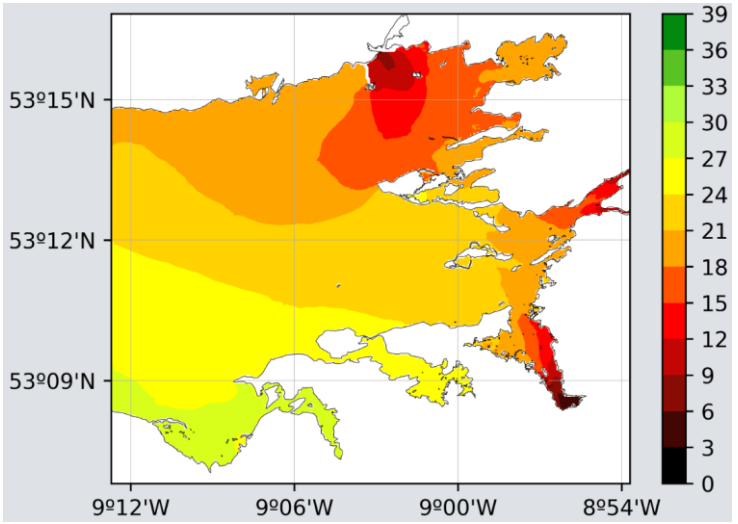


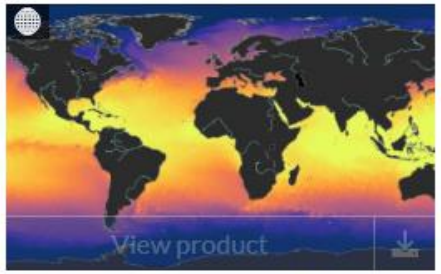
Fig. 2. Surface salinity during a wet period in March 2020.

BIODIVER-COAST Project Consortium

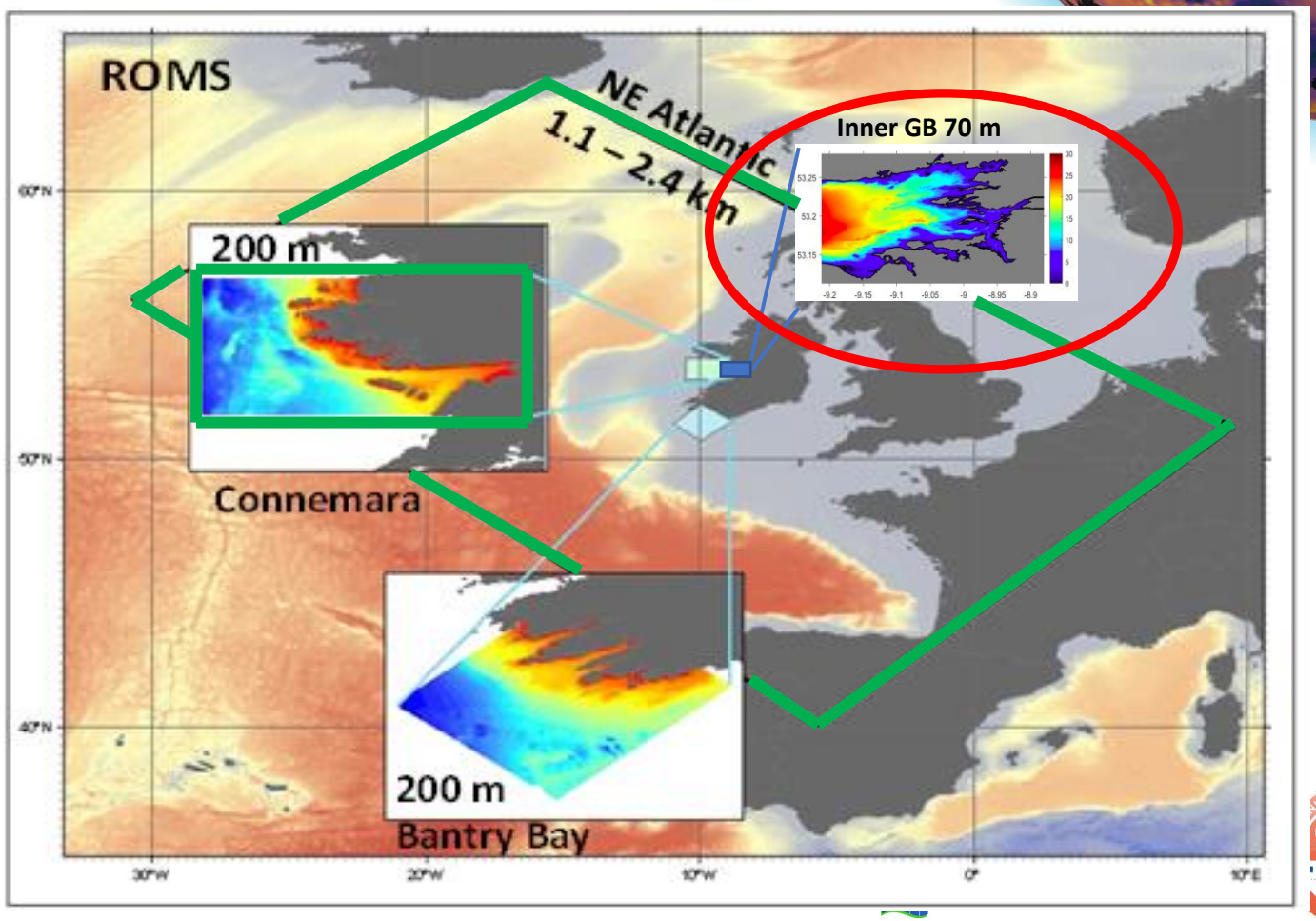
Marine Institute, Ireland
State agency responsible for marine research, technology development and innovation in Ireland.
https://www.marine.ie/

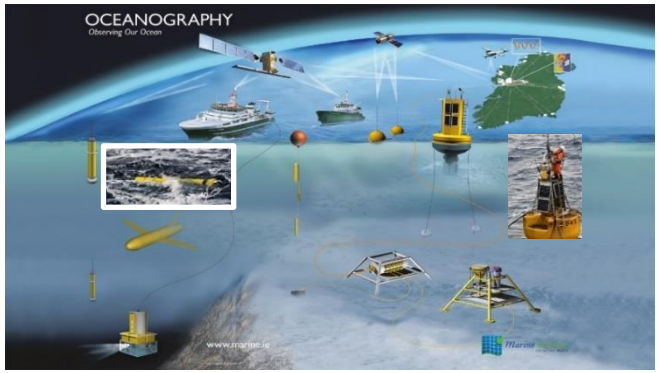
Nologin Oceanic Weather Systems, Spain
Developer of operational downstream coastal monitoring and forecasting services actively contributing to build Digital Twins of the Ocean and Coast
https://www.nowsystems.eu/

Galway Bay model – downscaled from the Copernicus GLO



Global Ocean Physics Analysis and Forecast





Galway Bay model

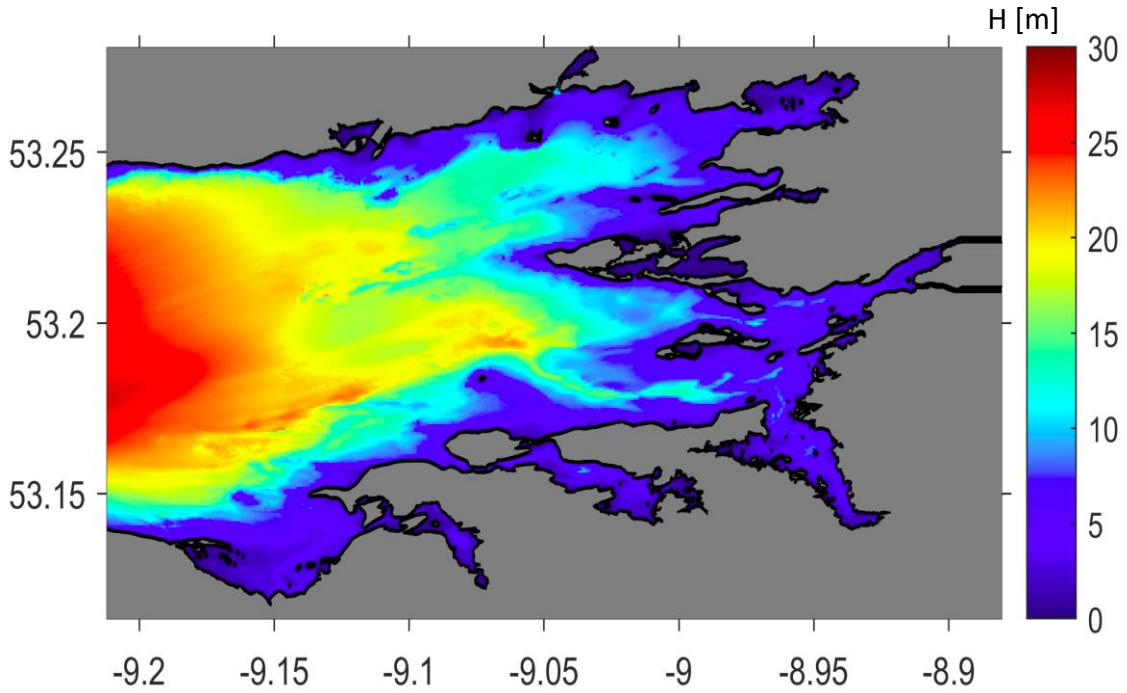


Fig 1. The extents and bathymetry of Galway Bay model

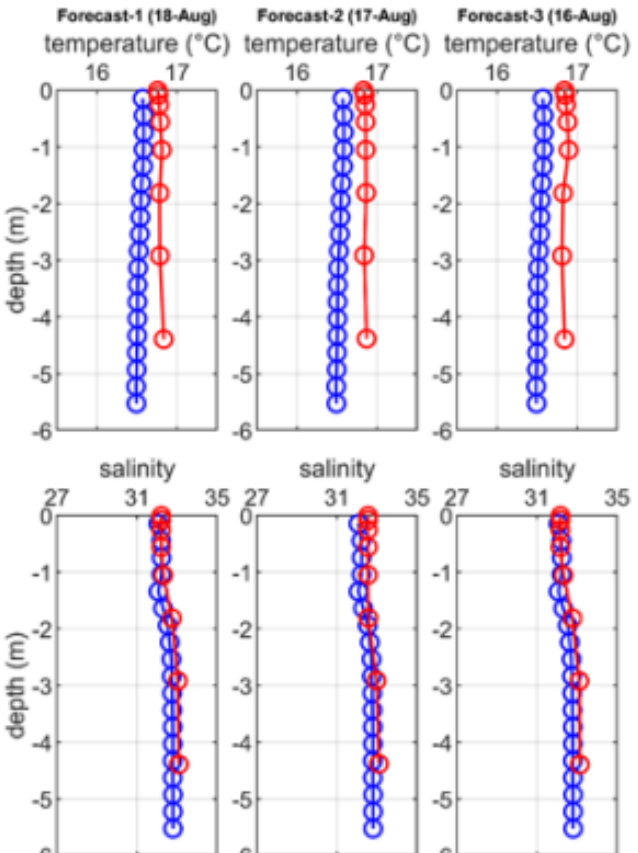
Lon 1 = 8.88 W
Lon 2 = 9.21 W

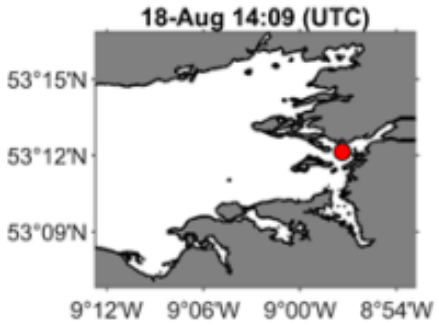
Lat 1 = 53.11 N
Lat 2 = 53.28 N

Horizontal resolution = 70 m
Vertical resolution = 8 sigma levels
Max depth = 30 m

Model validation

Quarterly CTD casts at c. 30 stations

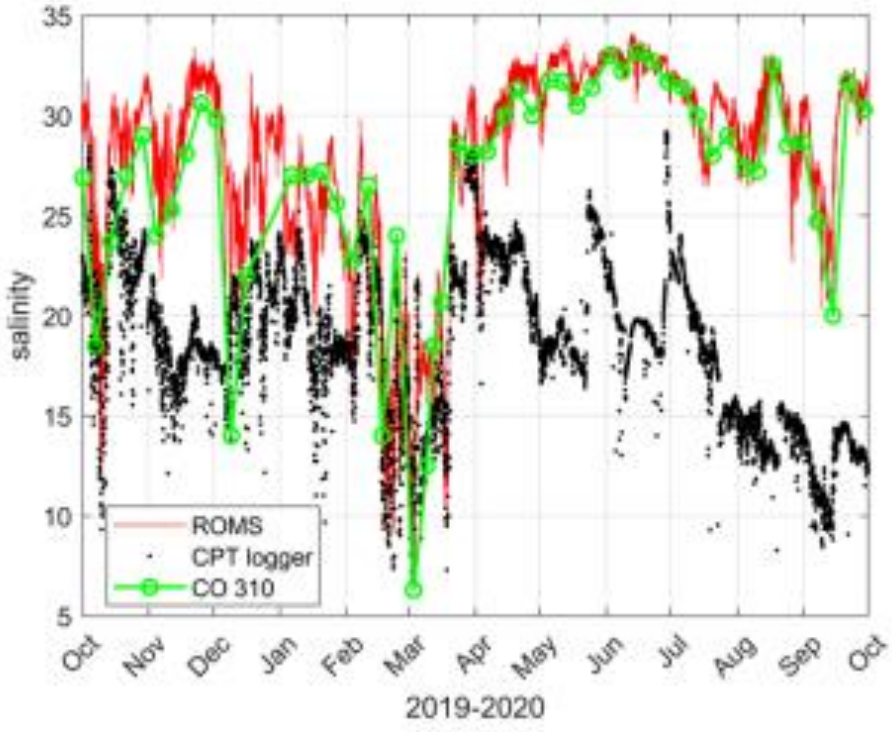




Temp.	F-1	F-2	F-3
MAE	0.25 °C	0.31 °C	0.30 °C
RMSD	0.26 °C	0.31 °C	0.30 °C
CORR	-0.44	0.16	0.78
Max(e)	0.33 °C	0.36 °C	0.34 °C
n	15	15	15

Salt	F-1	F-2	F-3
MAE	0.23	0.26	0.26
RMSD	0.25	0.29	0.29
CORR	0.95	0.92	0.95
Max(e)	0.41	0.48	0.41
n	15	15	15

All freshwater inputs are near-real-time updated daily.



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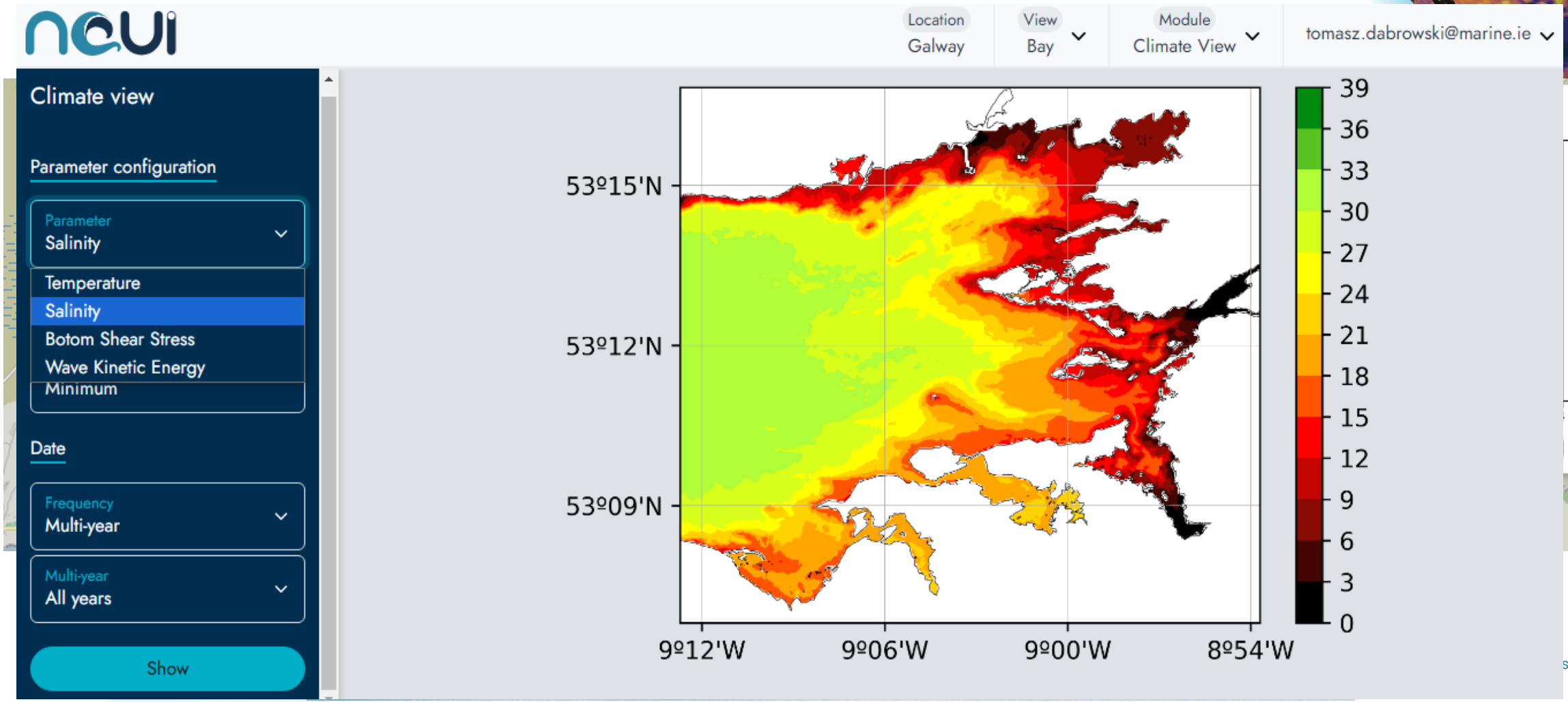
NAUI web portal



Downstream services – mapping marine conditions

- NAUI provides static layers with long-term (2012-2022) statistics provided
- Temperature, salinity, bottom stress and wave kinetic energy
- Means, anomalies, standard deviations, minimum, maximum, PC01, PC05, PC10, PC90, PC95, PC99
- Multiyear, annual, seasonal and monthly
- **Data has been used to map oyster mortality in Galway Bay based on T & S**

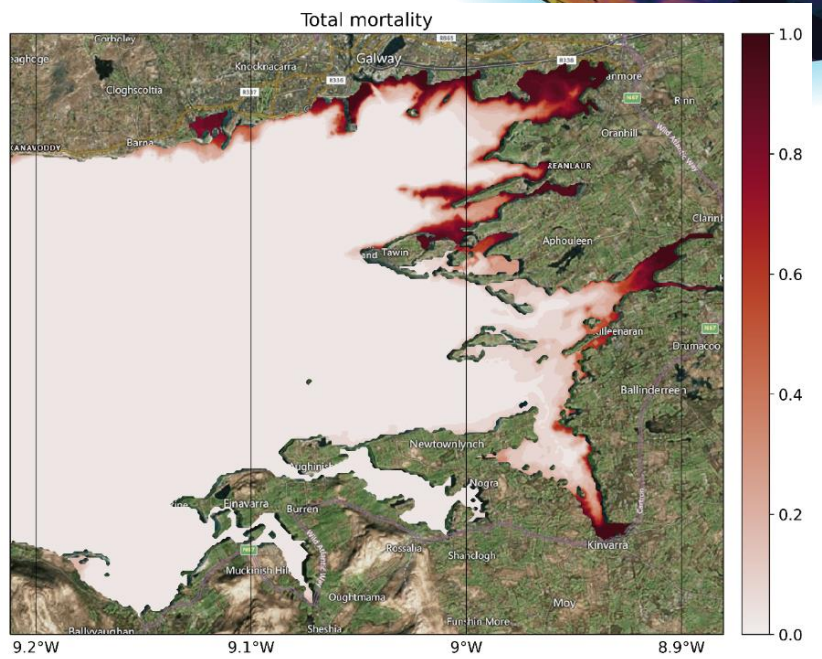
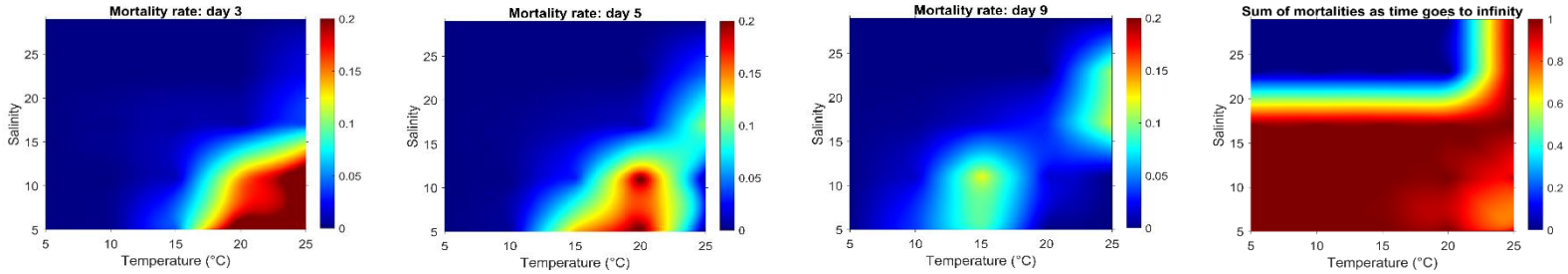
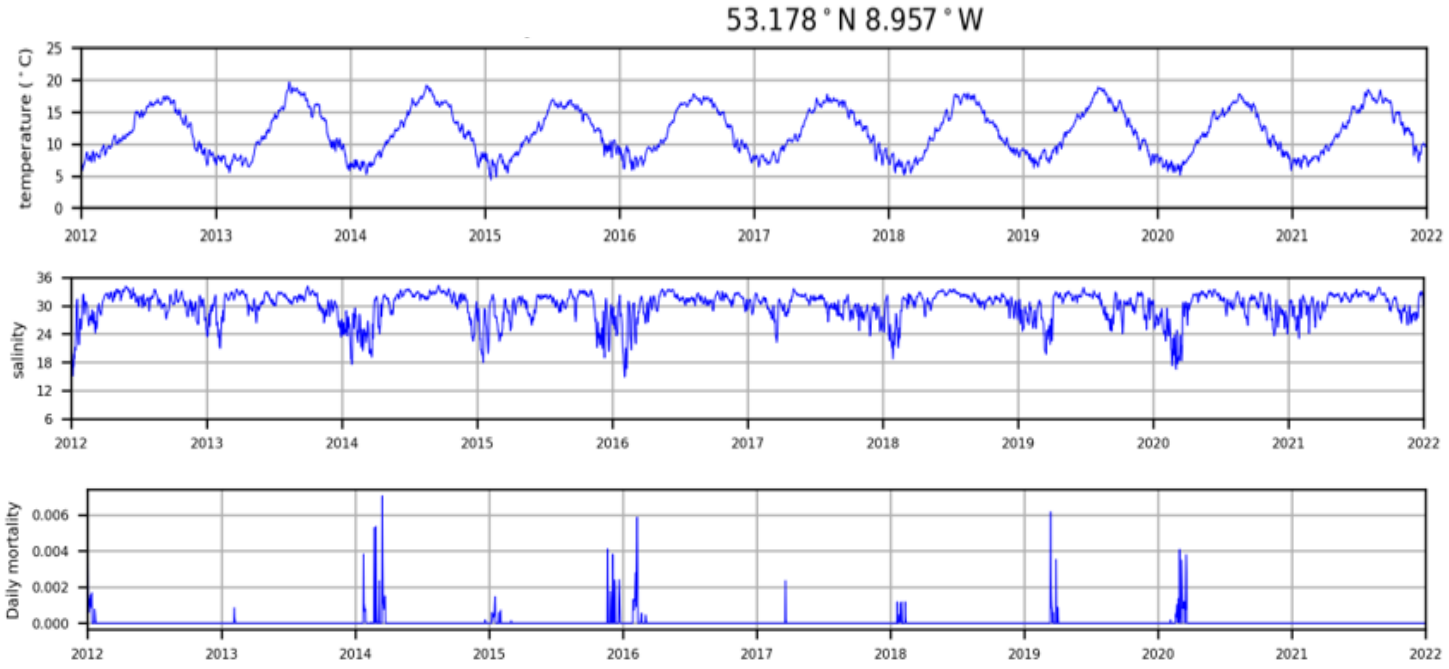


Fig. Oyster mortality computed from a 10 year hindcast

Downstream services – mapping marine conditions





$$M_d = M_d(T, S, \Delta t)$$

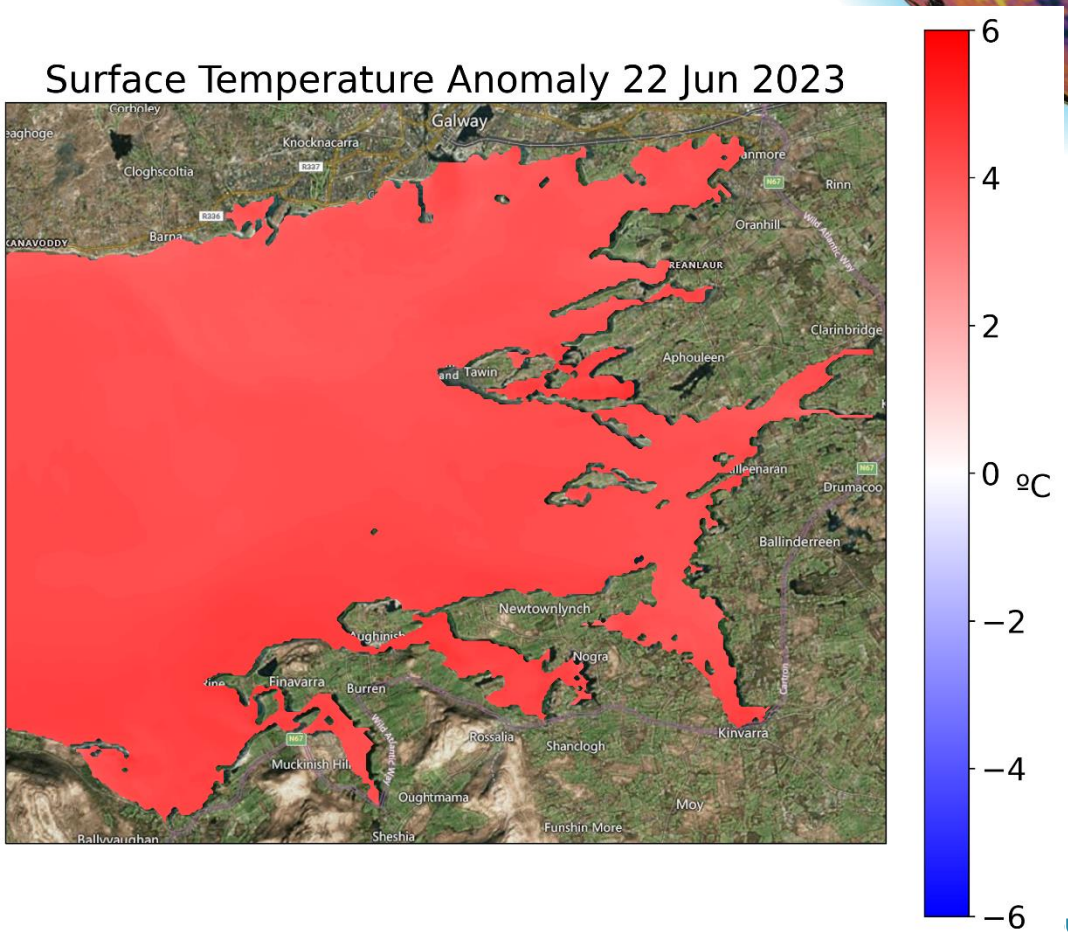
T – *daily average temperature*
S – *daily average salinity*
Δt – *exposure time in days*

The timeseries show that the spikes in mortality are exclusively down to drops in salinity in years 2012 – 2022,

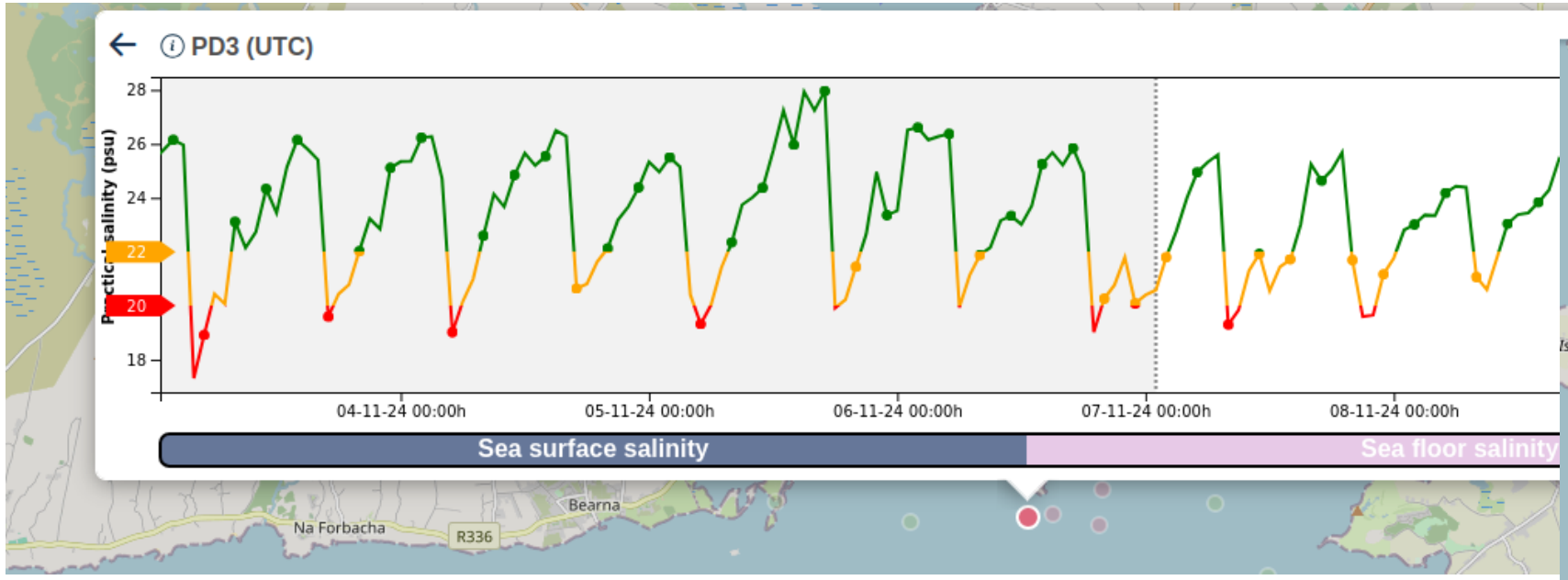
However, ...

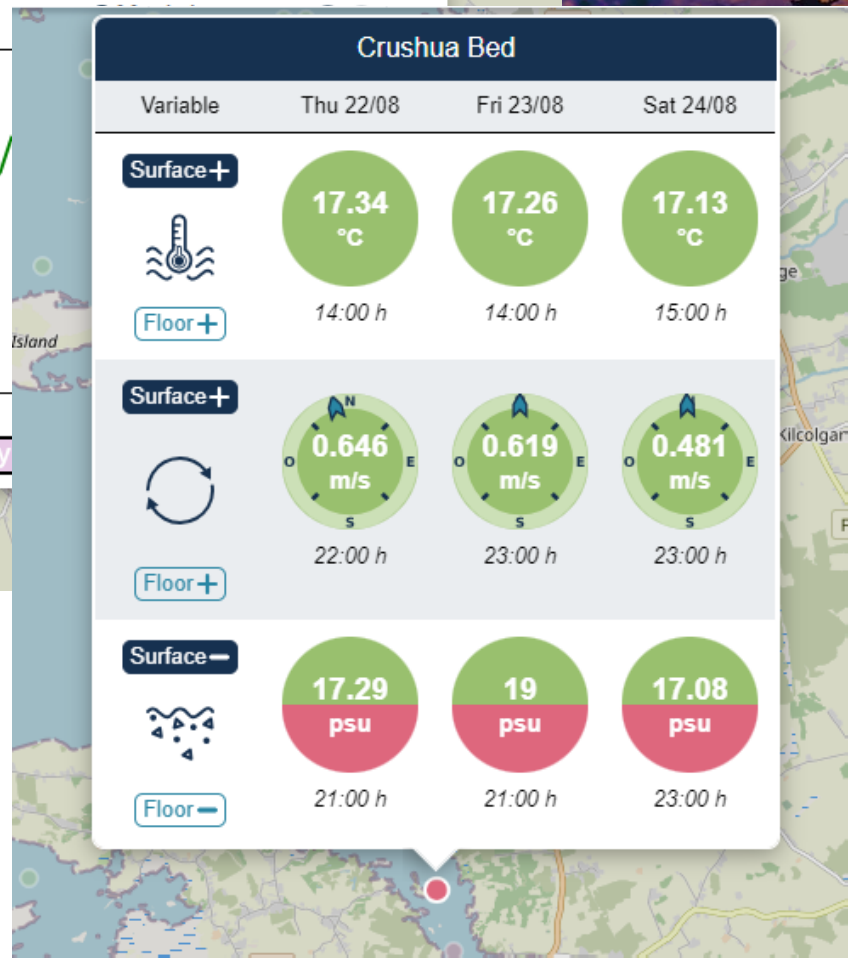
Downstream services – mapping marine conditions

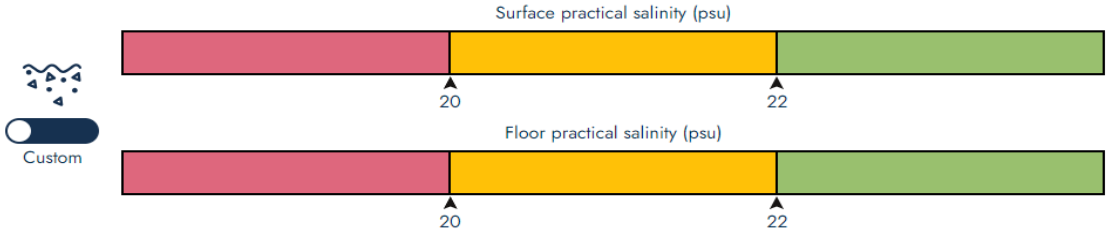
Marine Heat Wave in June 2023 – caused significant mortality, as reported by the oyster farmers.



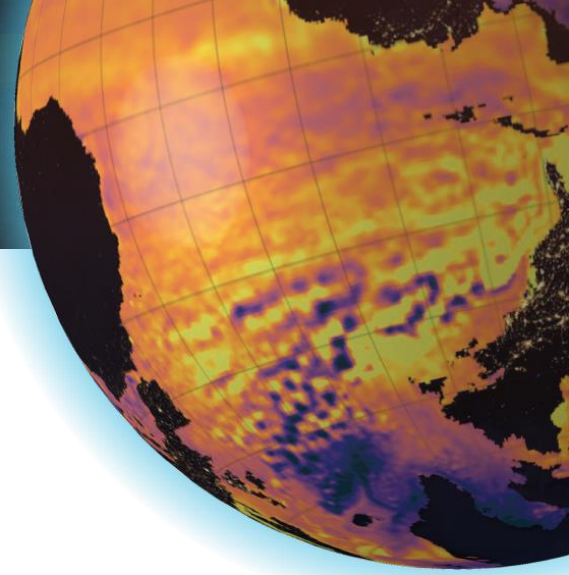
Downstream services – low salinity warning







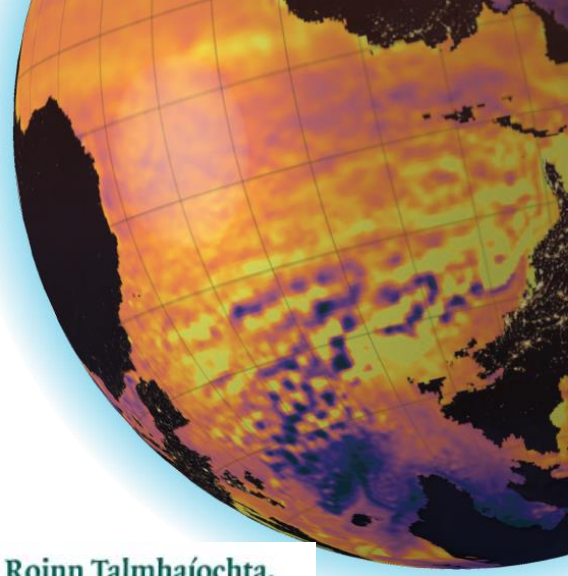
Warning thresholds customizable by users



Future

- **Geographical extension** of NAUI to include Dublin Bay
- Include the **biogeochemical EOVs** in the Service, relevance to e.g. WFD and MSFD
- Provision of new parameters for Galway Bay that are of interest to shellfish farmers, namely the **rate of change of temperature and salinity during extreme events.**
- Development of the **marine heatwaves monitoring** service for Galway Bay – of interest to shellfish and salmon farmers

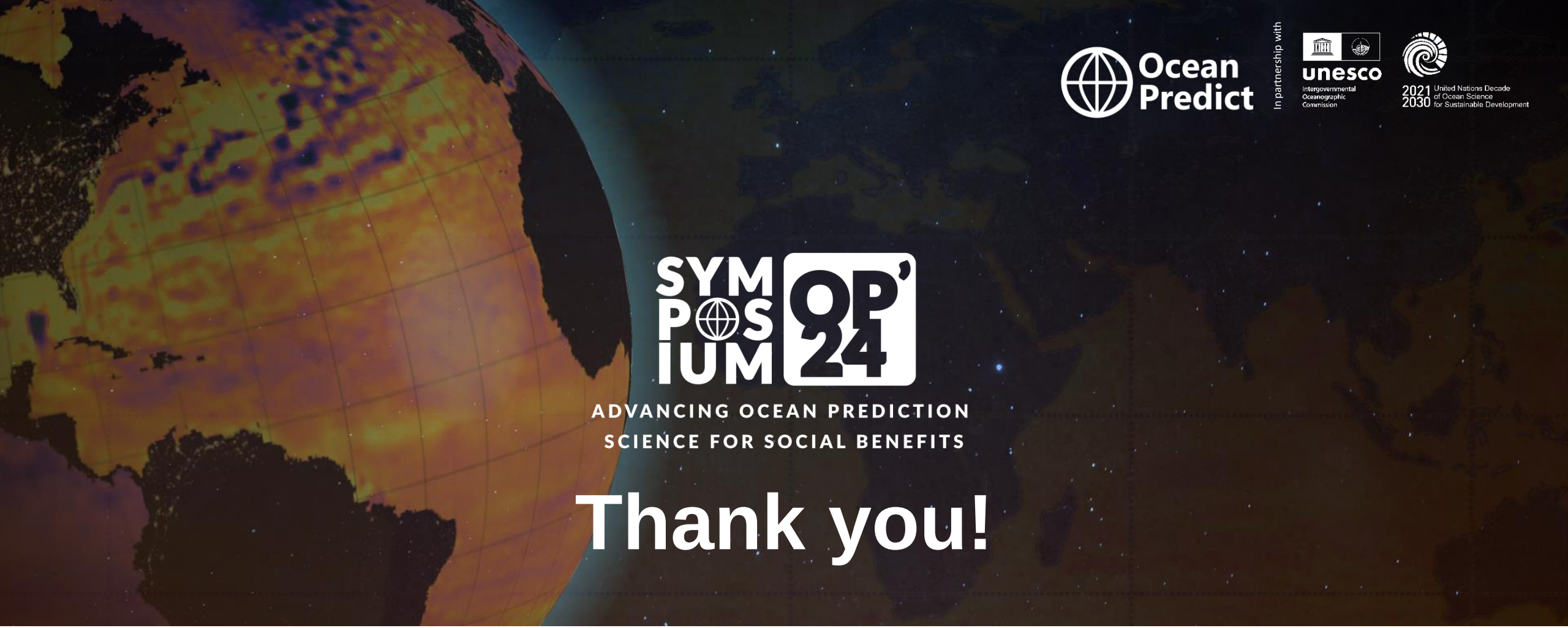
Acknowledgements



The Galway Bay model was developed as part of H2020 project FORCOAST

The government of Ireland funds the ongoing operation of the Galway Bay forecasting model by the Marine Institute

The presented service was developed as part of BIODIVER-COAST project, funded under the Copernicus Marine Service User Engagement Programme, UE 22050-COP-INNO USER



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