A coastal monitoring and forecasting system for Galway Bay and Dublin Bay, Ireland – services for aquaculture, biodiversity restoration and environmental monitoring.

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Outline

Motivation
Backgrounds & stakeholders needs

Galway Bay and Dublin Bay Models
Model extent and forcing

NAUI service
An online platform providing services to the end users

Downstream services
Mapping marine conditions, MHW, low salinity warning

Galway Bay

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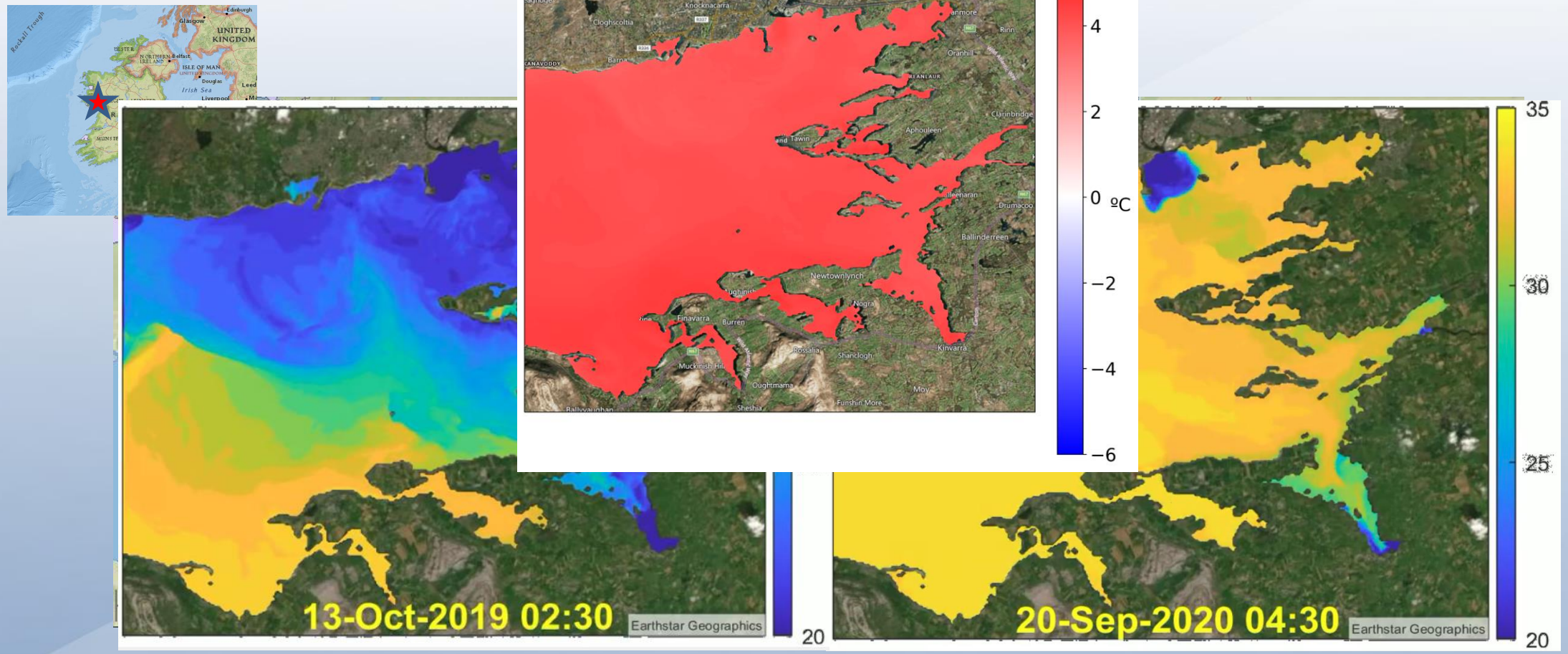
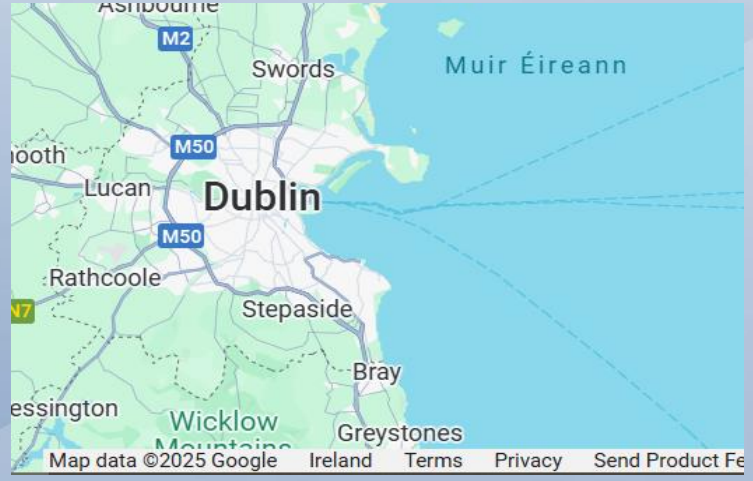


Dublin Bay

Biggest population centre in Ireland. Main interest is for the purpose of WFD monitoring and reporting.



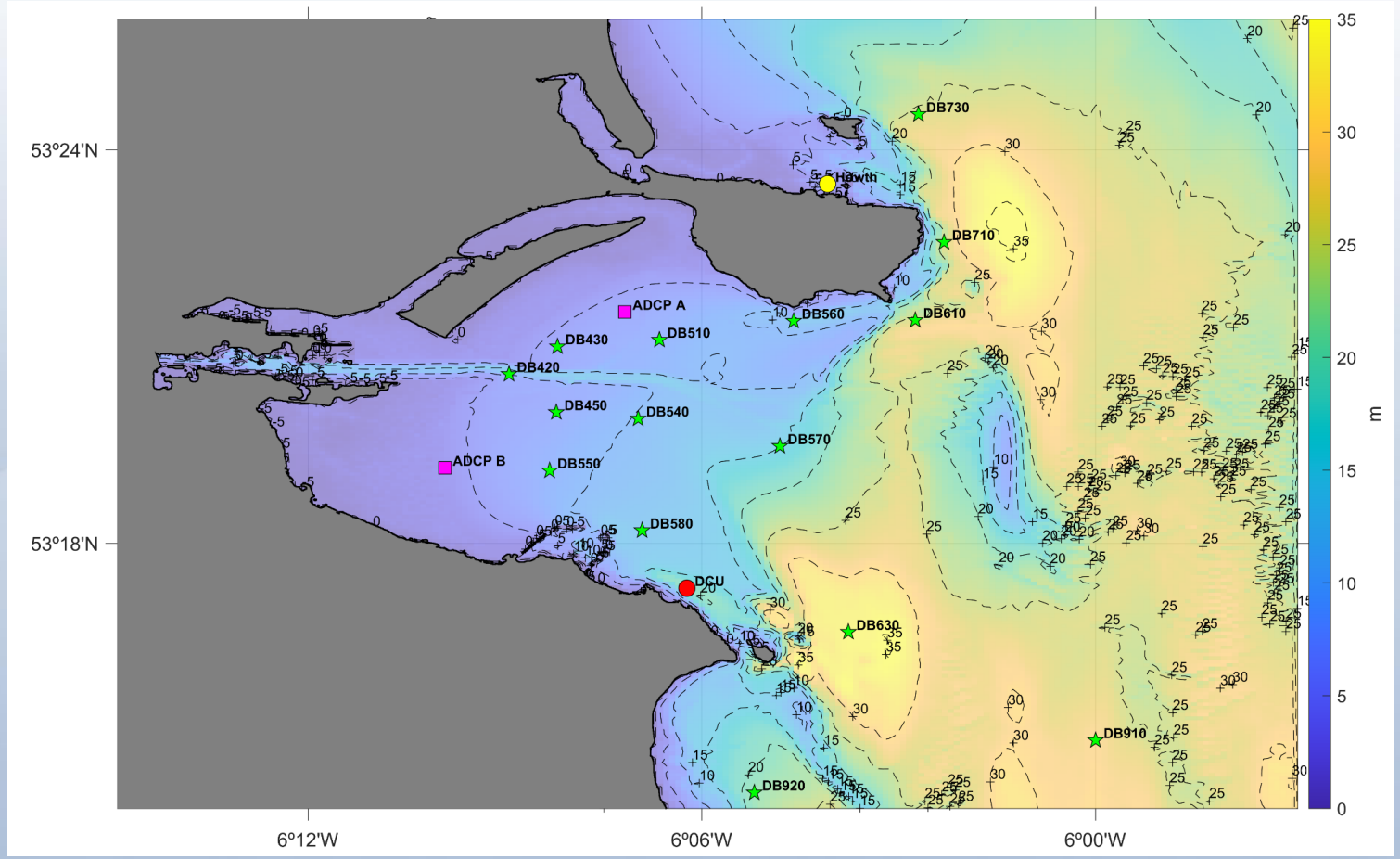


Fig. 1. Dublin Bay bathymetry

Stakeholders needs

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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)

Services:

- mapping marine conditions (example Fig. 1)
- low salinity warning (example Fig. 2)
- Marine heatwaves monitoring
- Rate of change of temperature and salinity

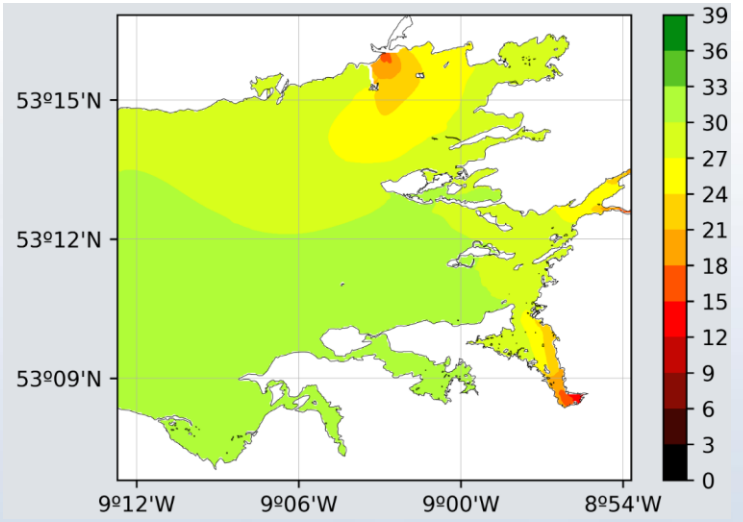

Fig. 1. Long-term (2012 – 2022) average surface salinity.

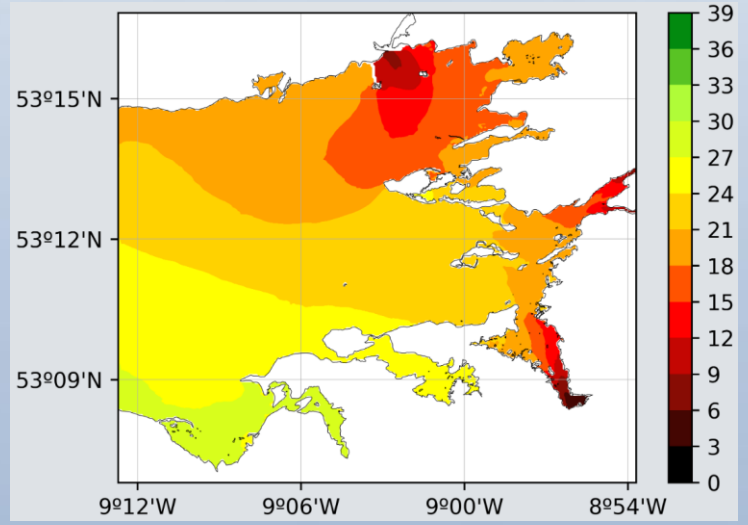

Fig. 2. Surface salinity during a wet period in March 2020.

Both models part of the operational forecasting system
ROMS + CROCO (& PISCES)

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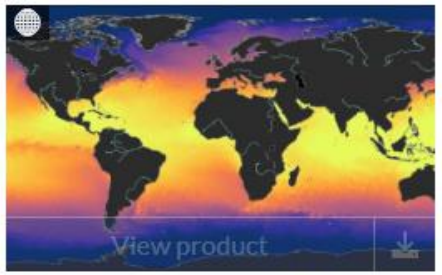
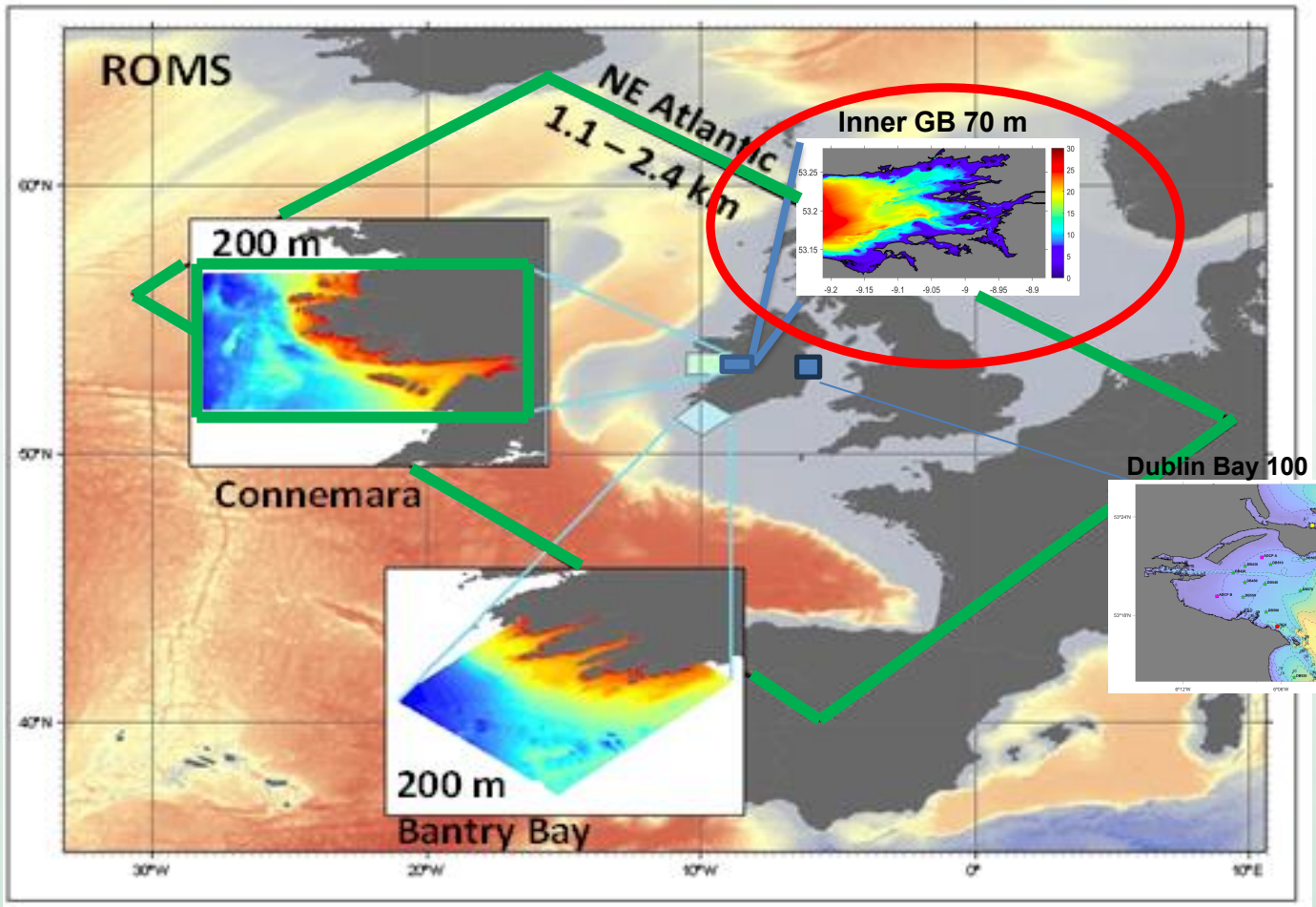
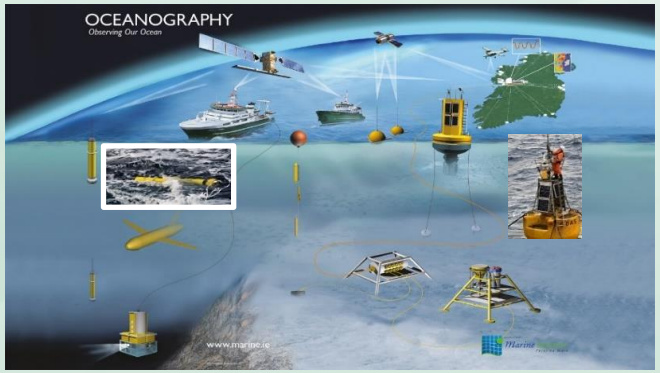
IBI Analysis
and Forecast

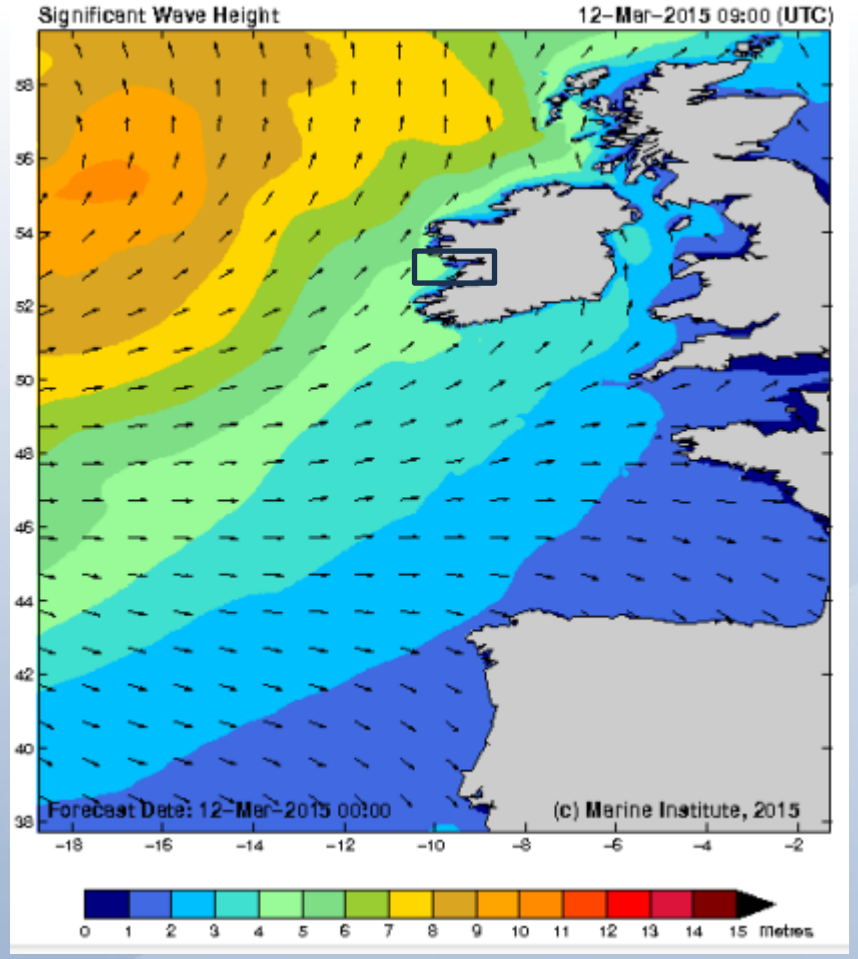


Global Ocean Physics Analysis
and Forecast





Operational wave models
SWAN



NE ATL 0.025 deg
Connemara 200 m

Description	The East_Atlantic model is an implementation of SWAN for a domain covering Irish coastal and oceanic waters.
Type	Hindcast and Forecast Wave parameters
Code	SWAN 40.91A
Grid size	800x940
Resolution	0.025 degrees
Initialisation	Each daily simulation is a 13-day simulation initialised from rest
Wind Forcing	1-Hourly ECMWF operational forcing
Open Boundary Conditions	CMEMS global wave model, GLOBAL_ANALYSIS_FORECAST_WAV_001_027-TDS
Data assimilation	No
Simulation length	13 days: 7-day ramp-up/hindcast; 6-day forecast
Model Run Frequency	Daily
Model Output	3-hourly for spatial fields; 30-minute time series at discrete locations. Format is Matlab binary (*.mat files)

Galway Bay model

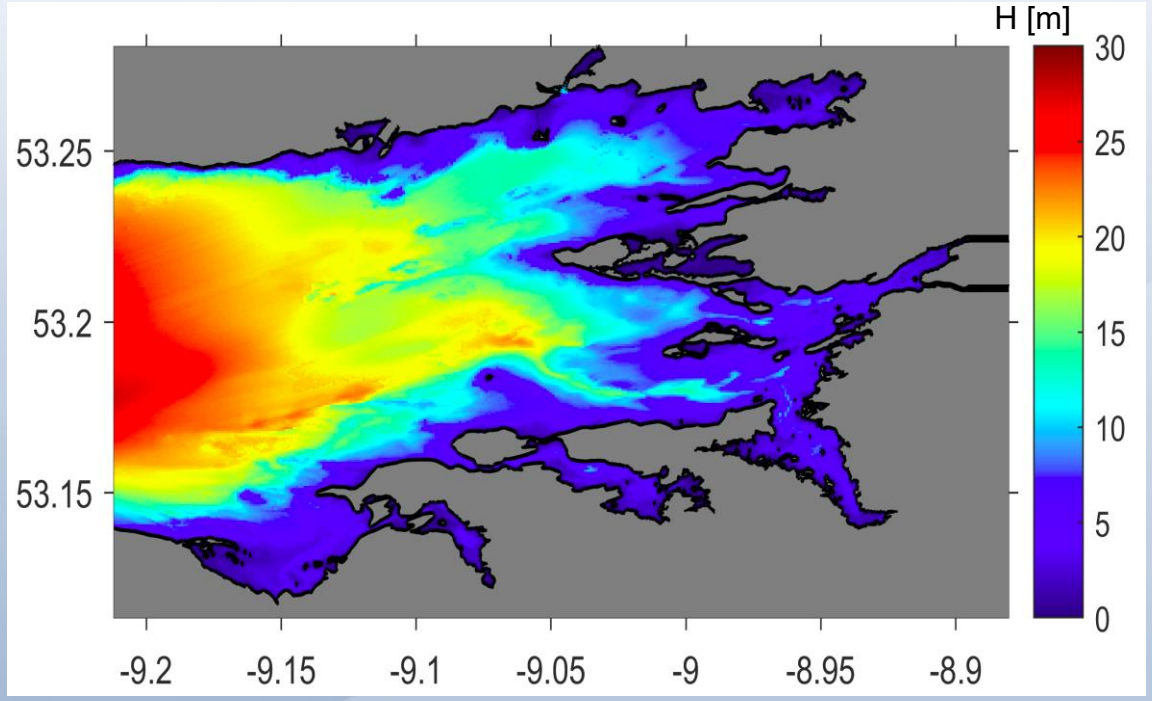


Fig 1. The extents and bathymetry of Galway Bay model

Lon 1 = 8.88 W
Lon 2 = 9.21 W

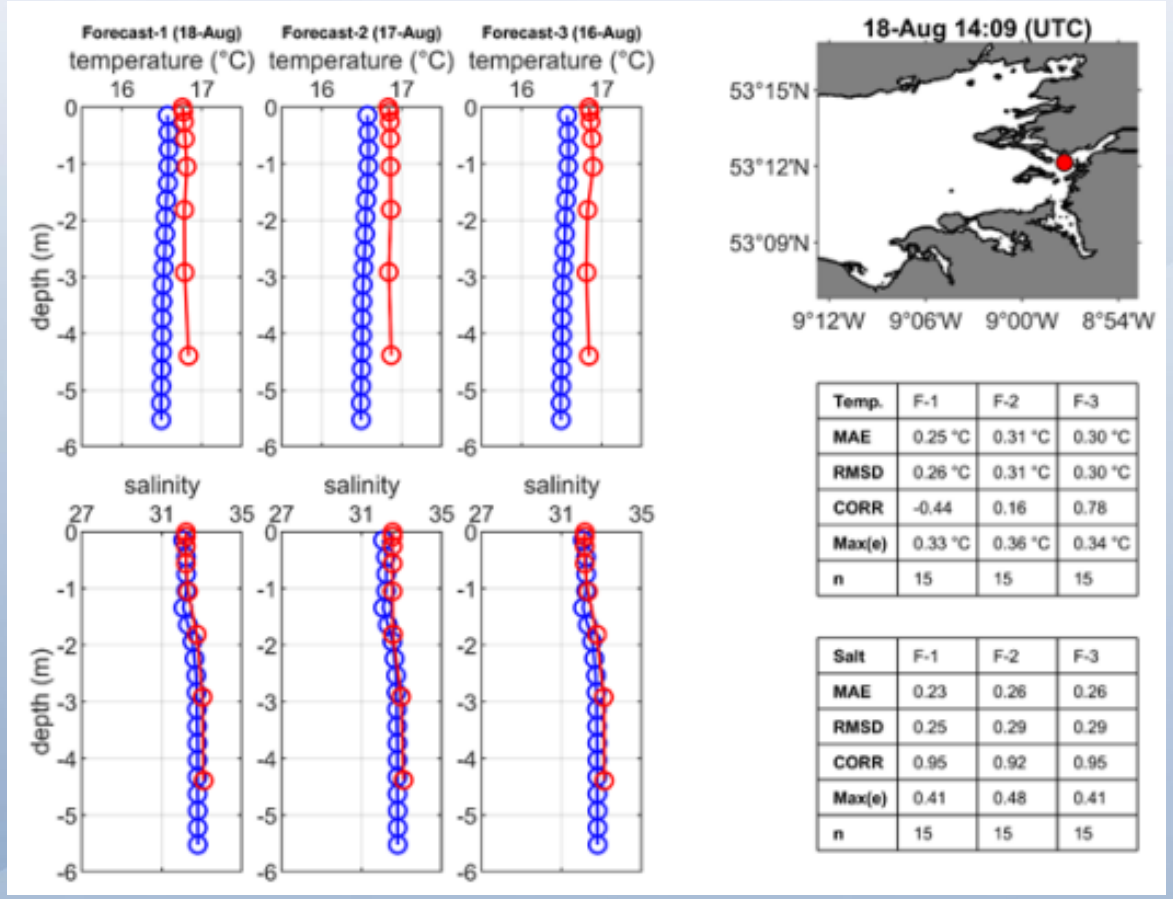
Lat 1 = 53.11 N
Lat 2 = 53.28 N

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

Wetting/drying – about 20% of the area is intertidal

Model validation

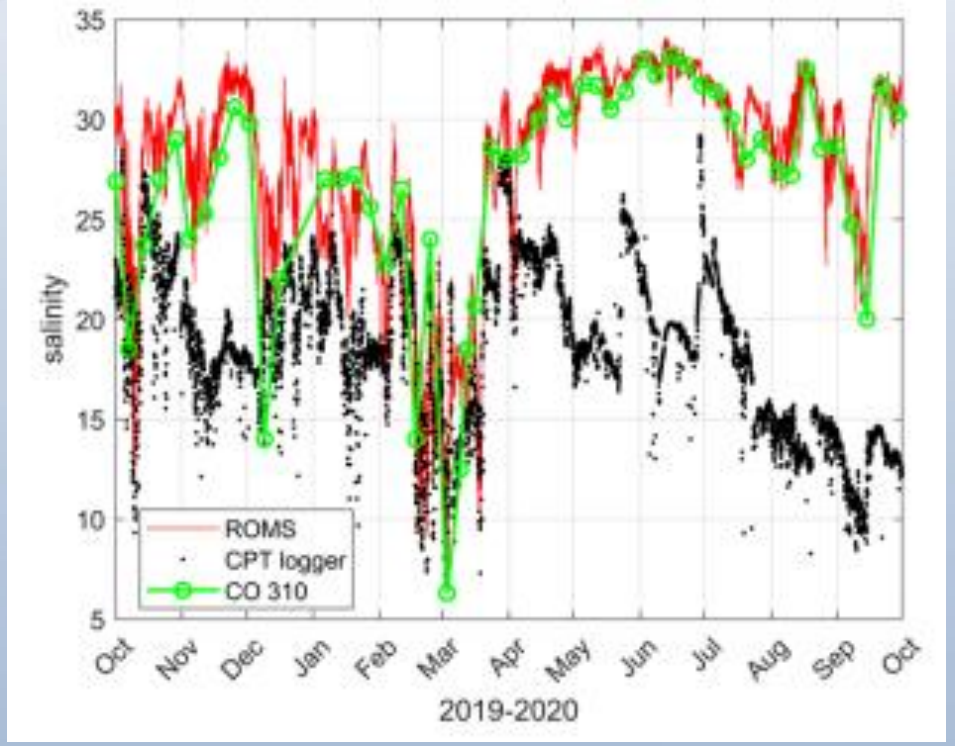
Quarterly CTD casts at c. 30 stations



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.



NAUI web portal

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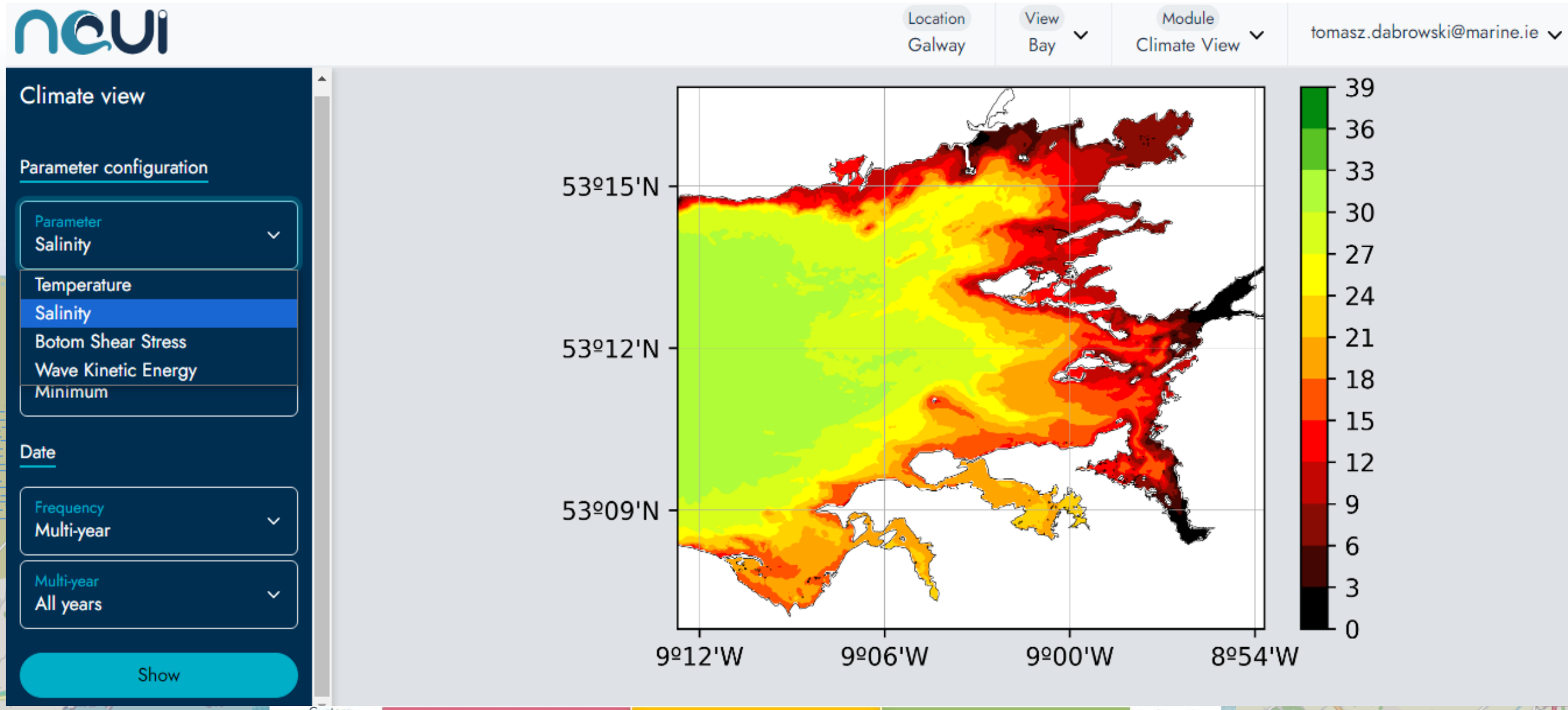

Downstream services

Mapping marine conditions

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- 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**

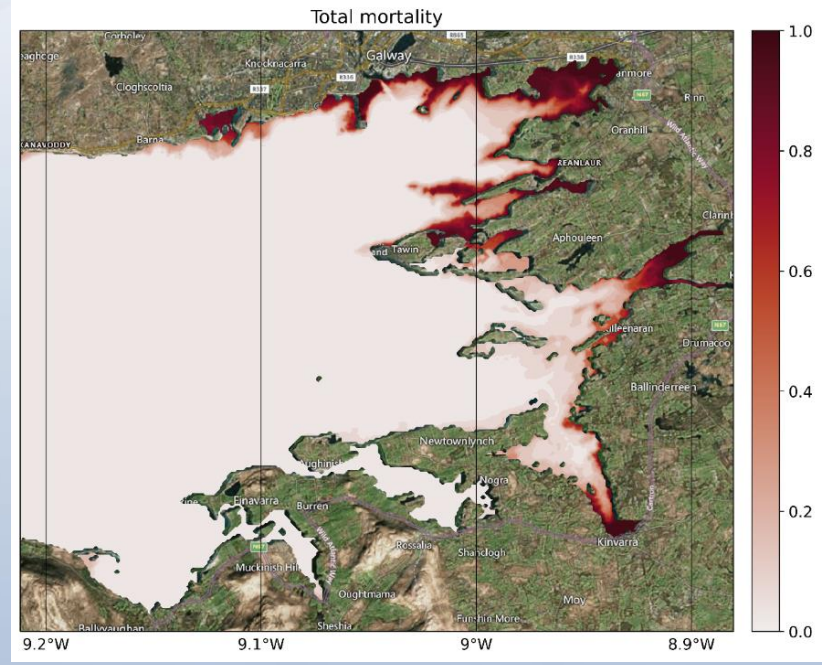

Fig. Oyster mortality computed from a 10 year hindcast

Downstream services

Mapping marine conditions

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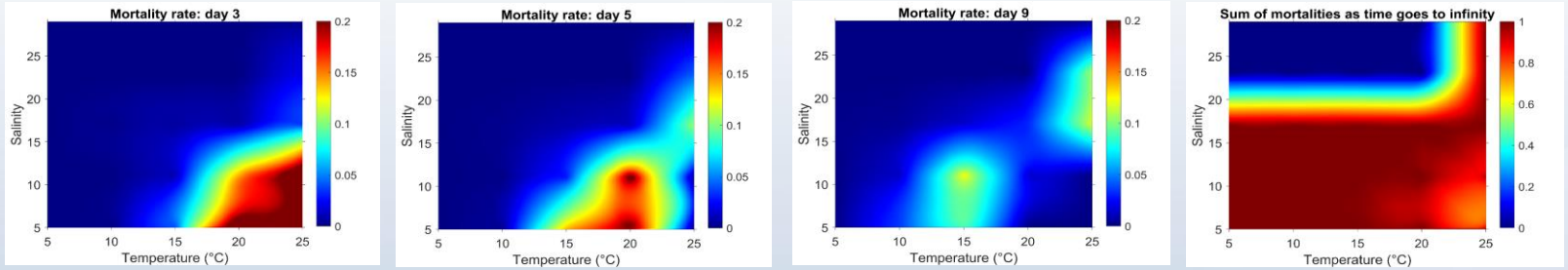
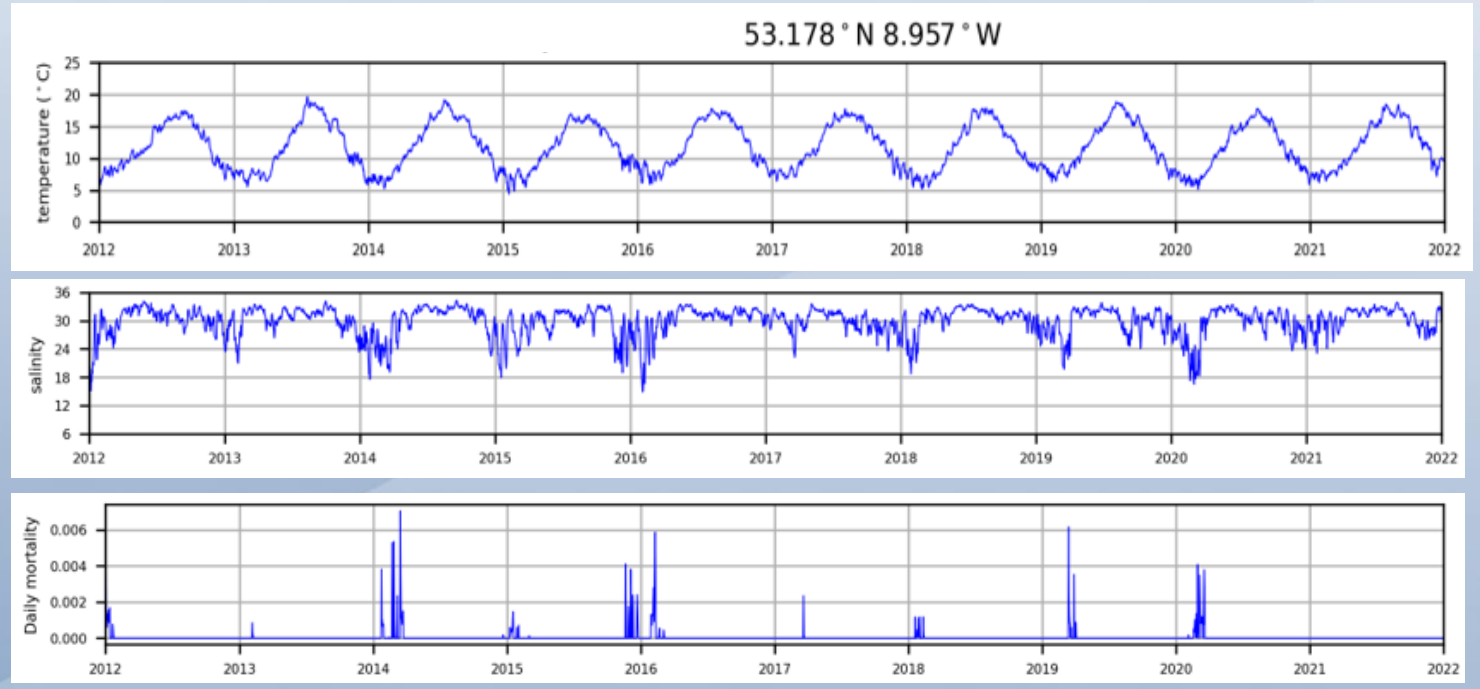


$$M_d = M_d(T, S, \Delta t)$$

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

Marine Heatwaves Monitoring

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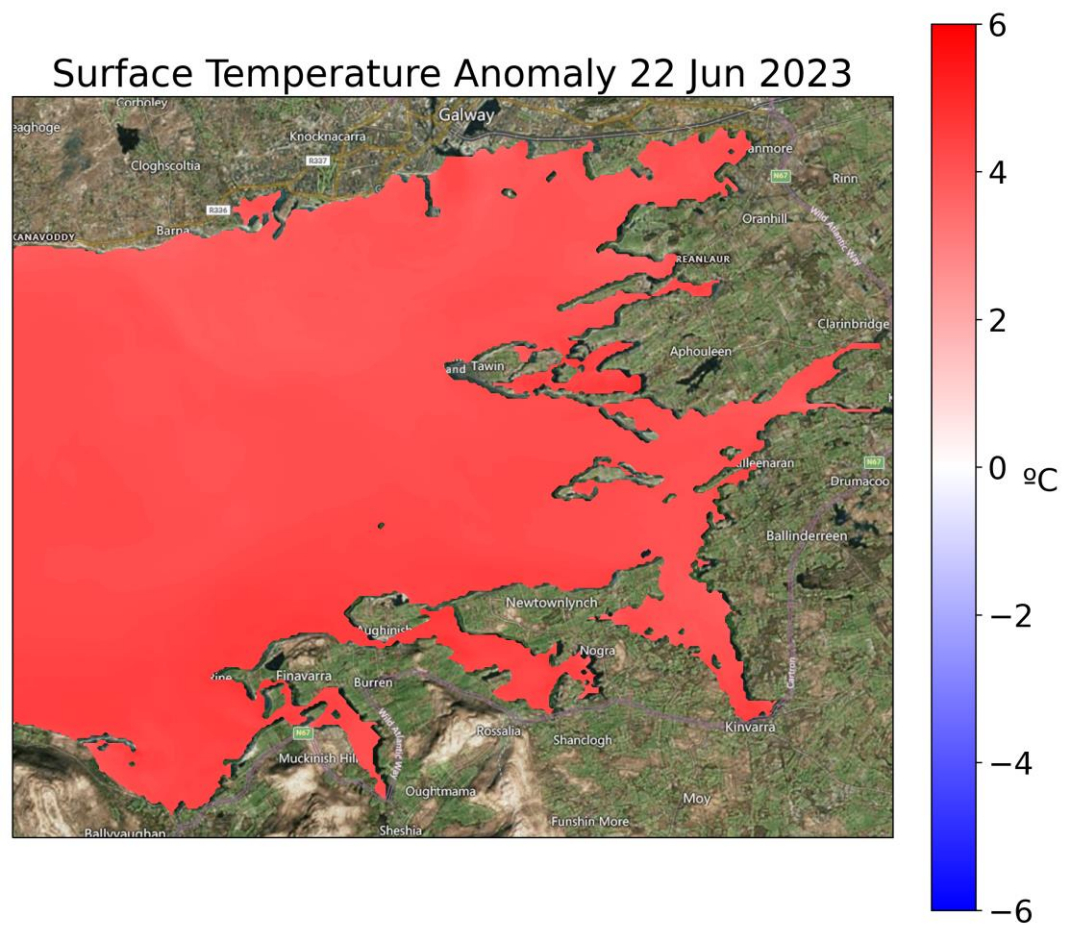
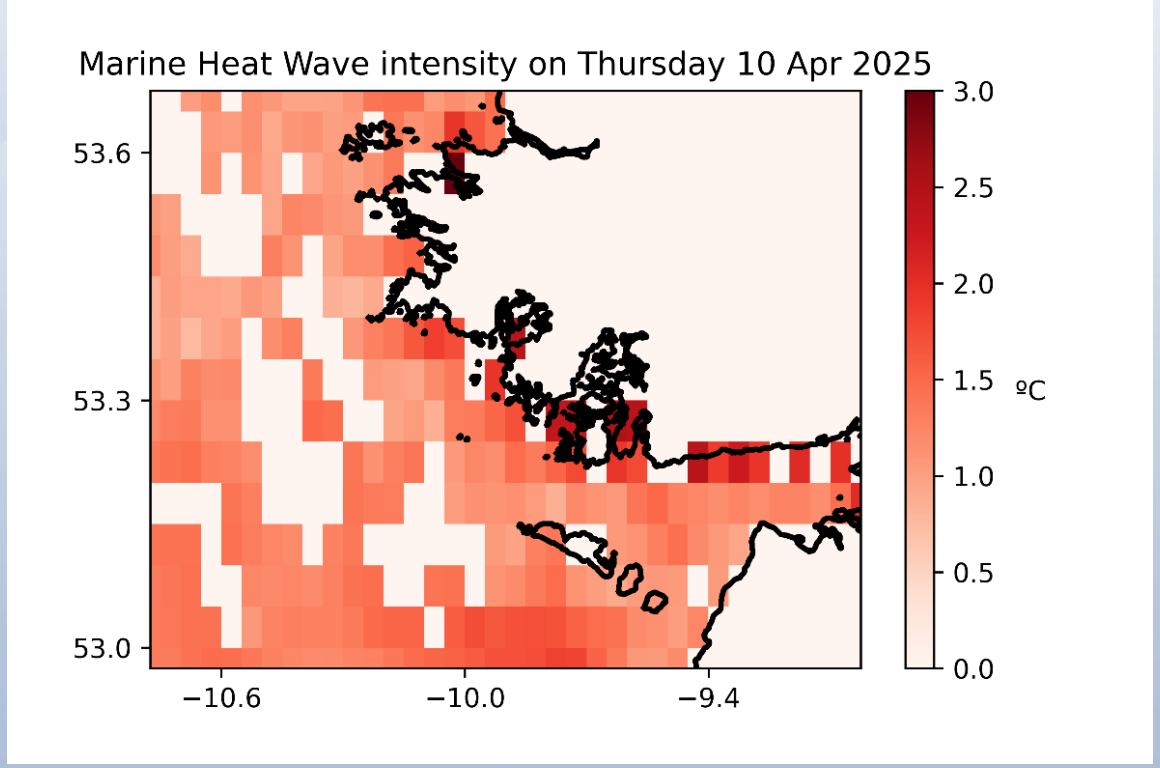
Marine Heat Wave in June 2023 – caused significant mortality, as reported by the oyster farmers.

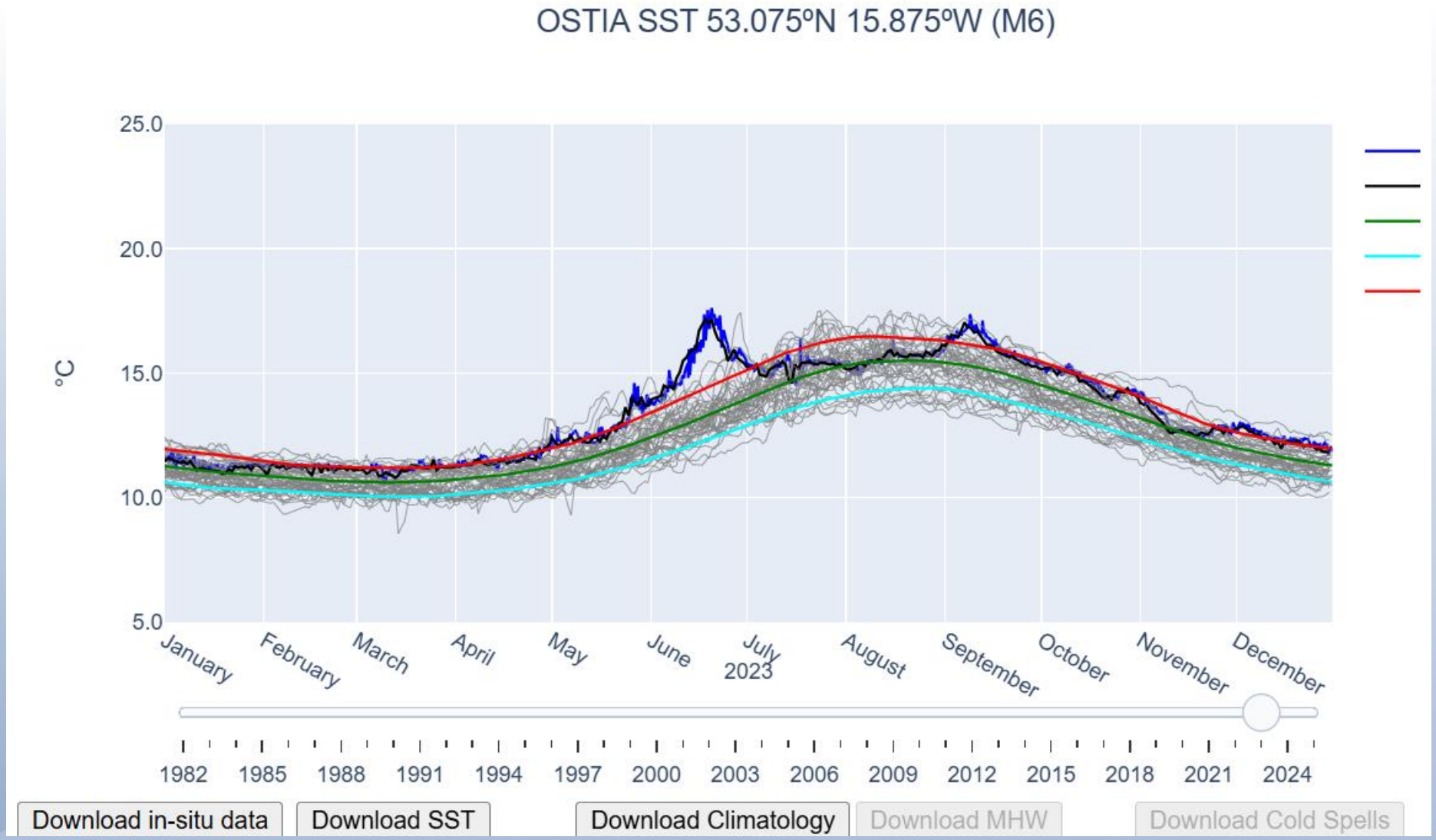


Marine Heat Wave in April 2025 – we do not have any information on oyster mortality. Absolute temperatures were still low at this time.



Downstream services

Marine Heatwaves Monitoring



Jun 2023 MHW

https://www.marine.ie/site-area/data-services/remote-sensing/remote-sensing

Downstream services

Marine Heatwaves Monitoring

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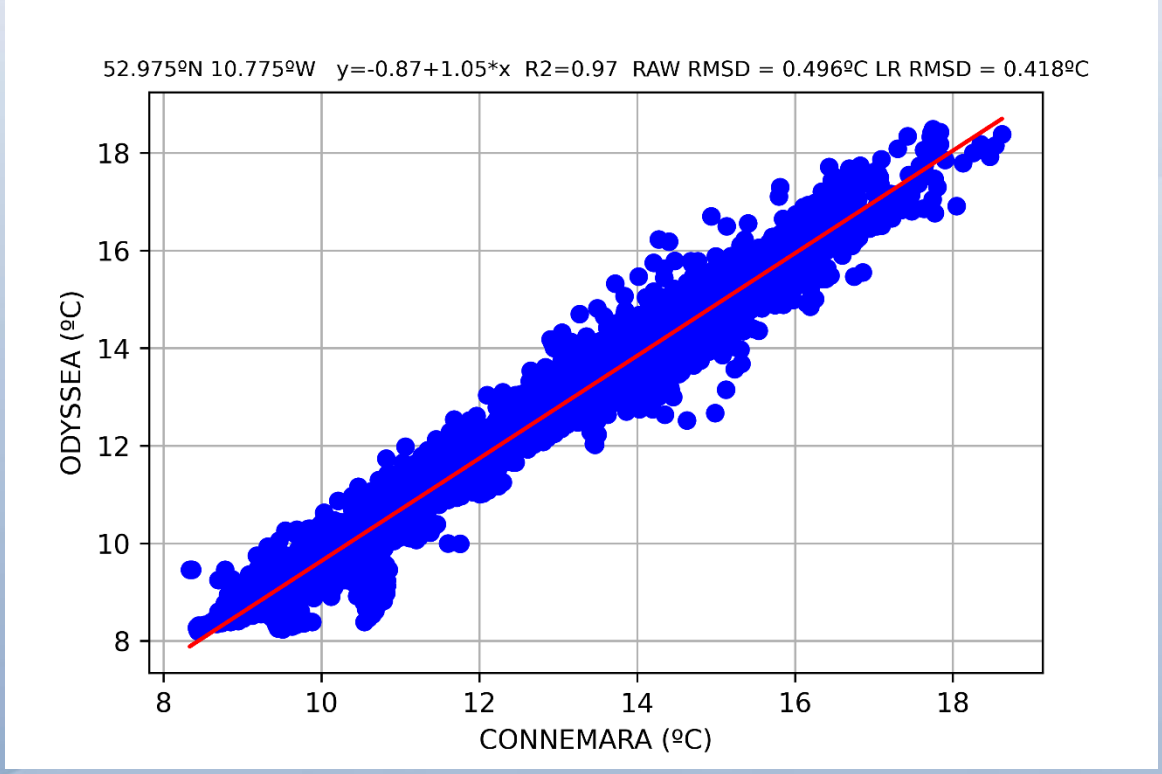
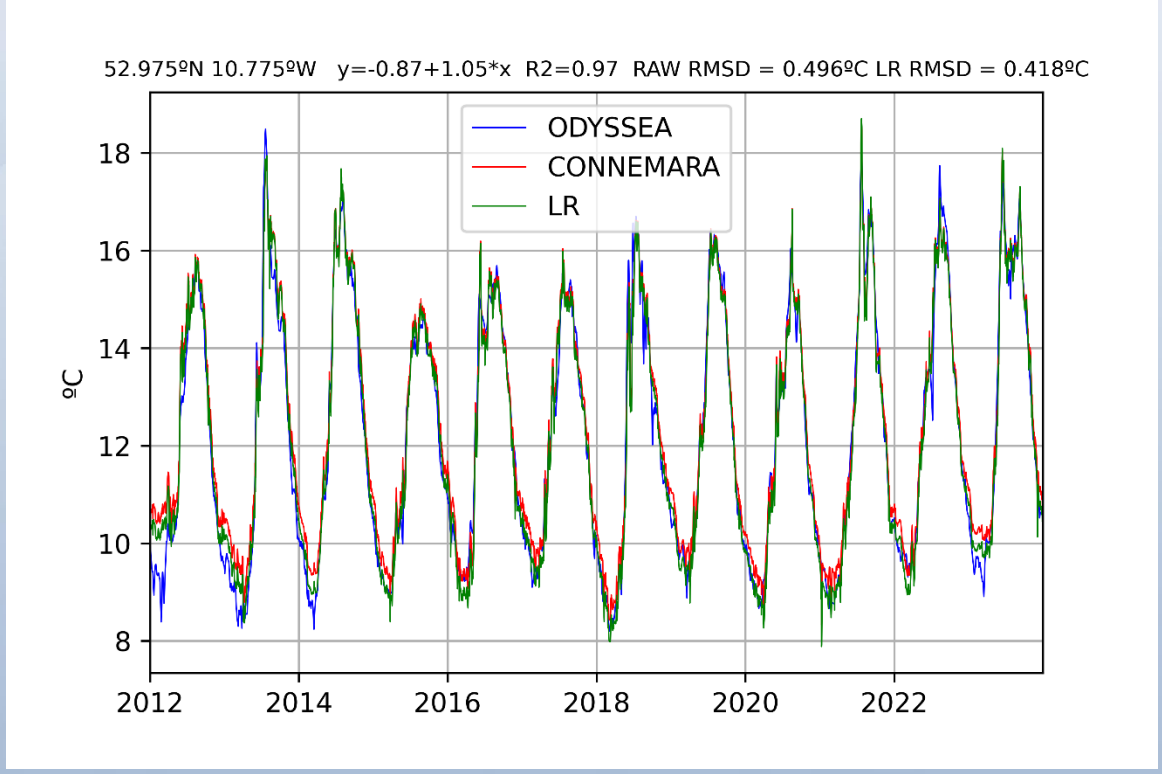
- Connemara model only provides output from 2012 onwards – insufficient to calculate climatology
- ODYSSEA L4 SST used as it offers best resolution for Galway Bay (https://doi.org/10.48670/moi-00152)
- We had to reduce the biases between ODYSSEA and Connemara before ODDYSEA could be used for the baseline





Downstream services

Marine Heatwaves Monitoring

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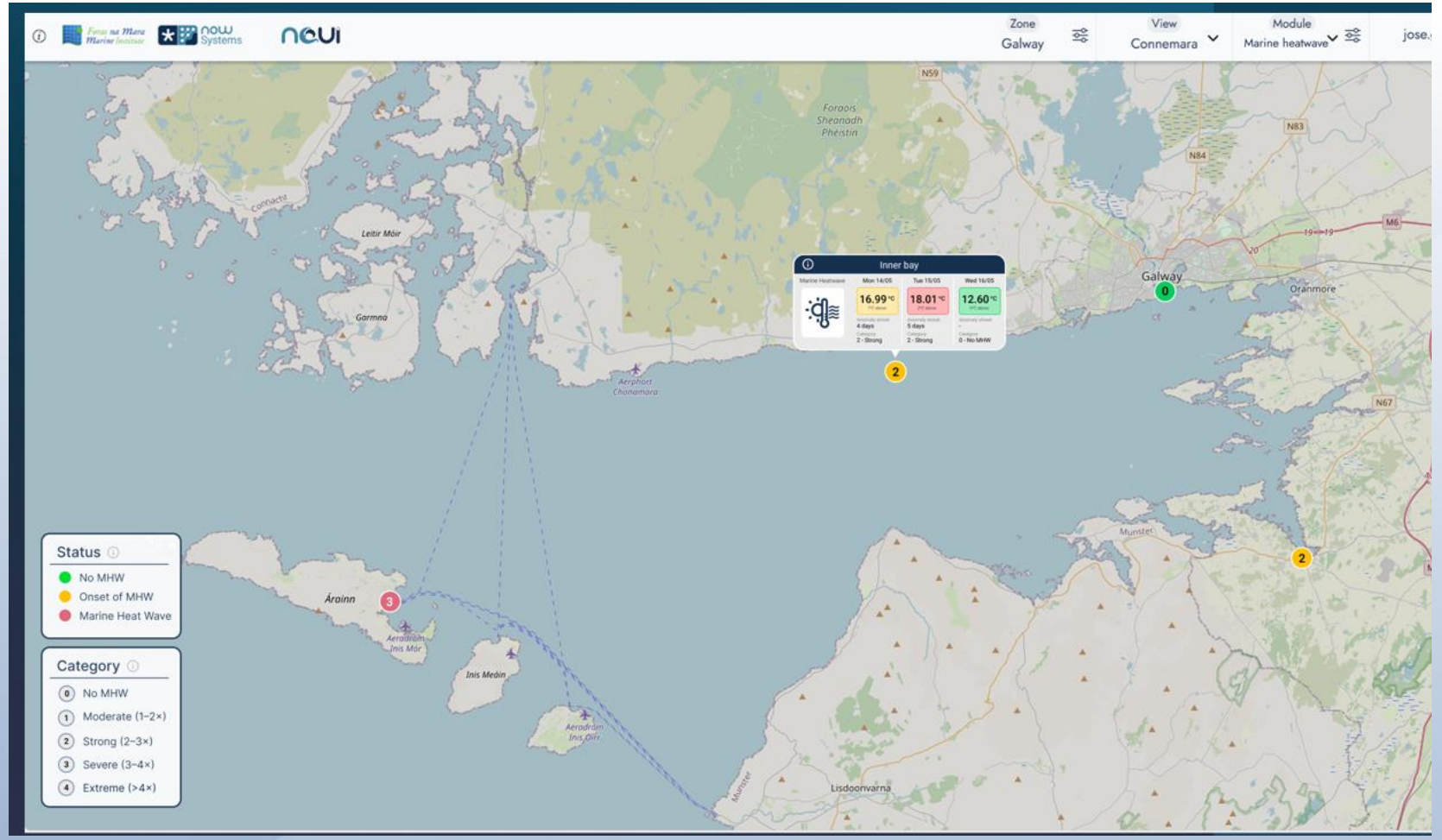
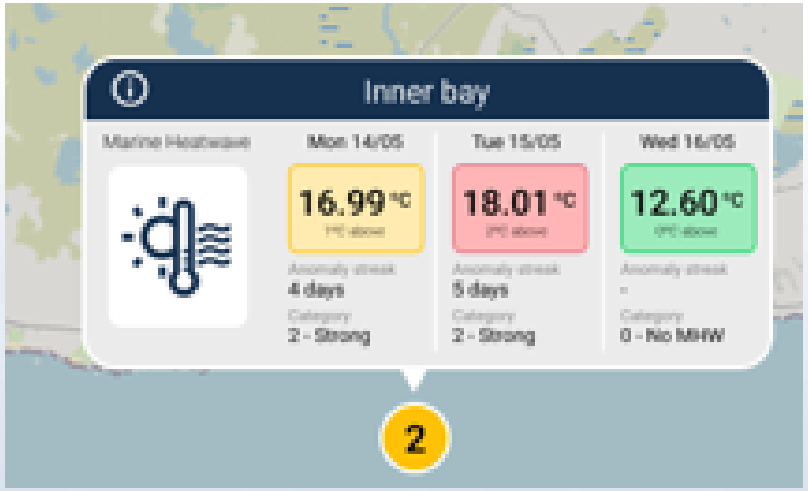
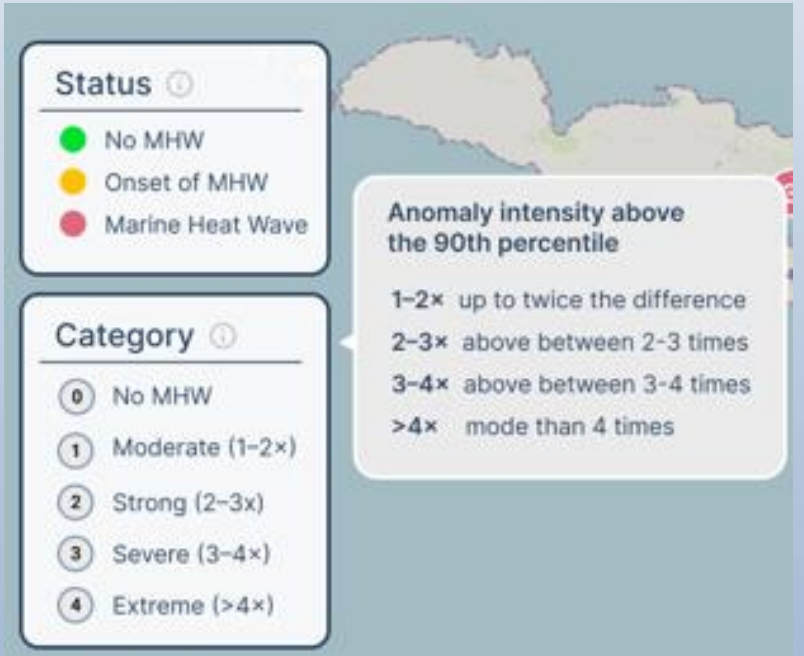
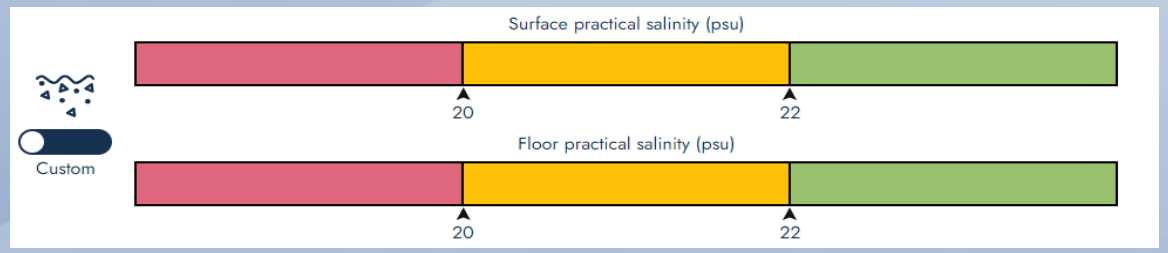






Downstream services

Low salinity warning



Warning thresholds customizable by users

Ongoing developments

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- **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.**

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