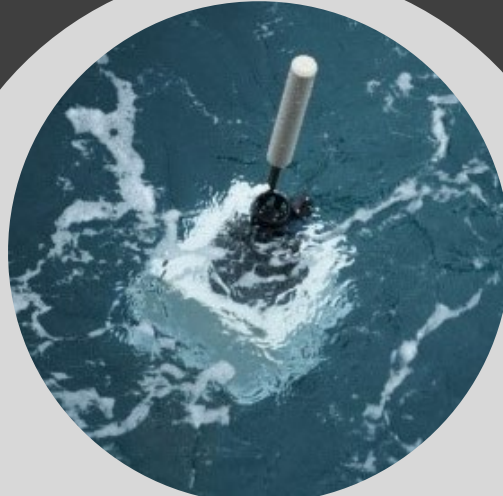


RV Celtic Explorer



Argo Float



Glider



Oxygen & Salinity Sampling

Ireland's Ocean & the impact of Climate Change on ecosystems

Presented by Caroline Cusack
on behalf the Marin Institute Colleagues & Co-authors of
the Irish Ocean Climate & Ecosystem Status Report



Context

Why should we care about the ocean?

Life support system for our planet

90% of excess heat caused by green house gas emissions is stored in the ocean

25% of carbon dioxide emissions from human activities is absorbed by the ocean

71% of the Earth's surface is covered by ocean

97% of the Earth's water is contained in our oceans and seas

50% The ocean is responsible for 50% of primary production on Earth, sustaining our food system

The ocean helps to regulate the global climate, therefore, the future climate depends on the state of our ocean.

Why the ocean matters to us as an Island nation?

The Irish Coastline is 7,711Km long

40% of the Irish Population lives within 5 Km of the coast

Under EU classification, >90% of the island of Ireland is a coastal zone

Ireland's marine territory is 10 times the size of its land mass

880,000 Km²

€6.2 billion

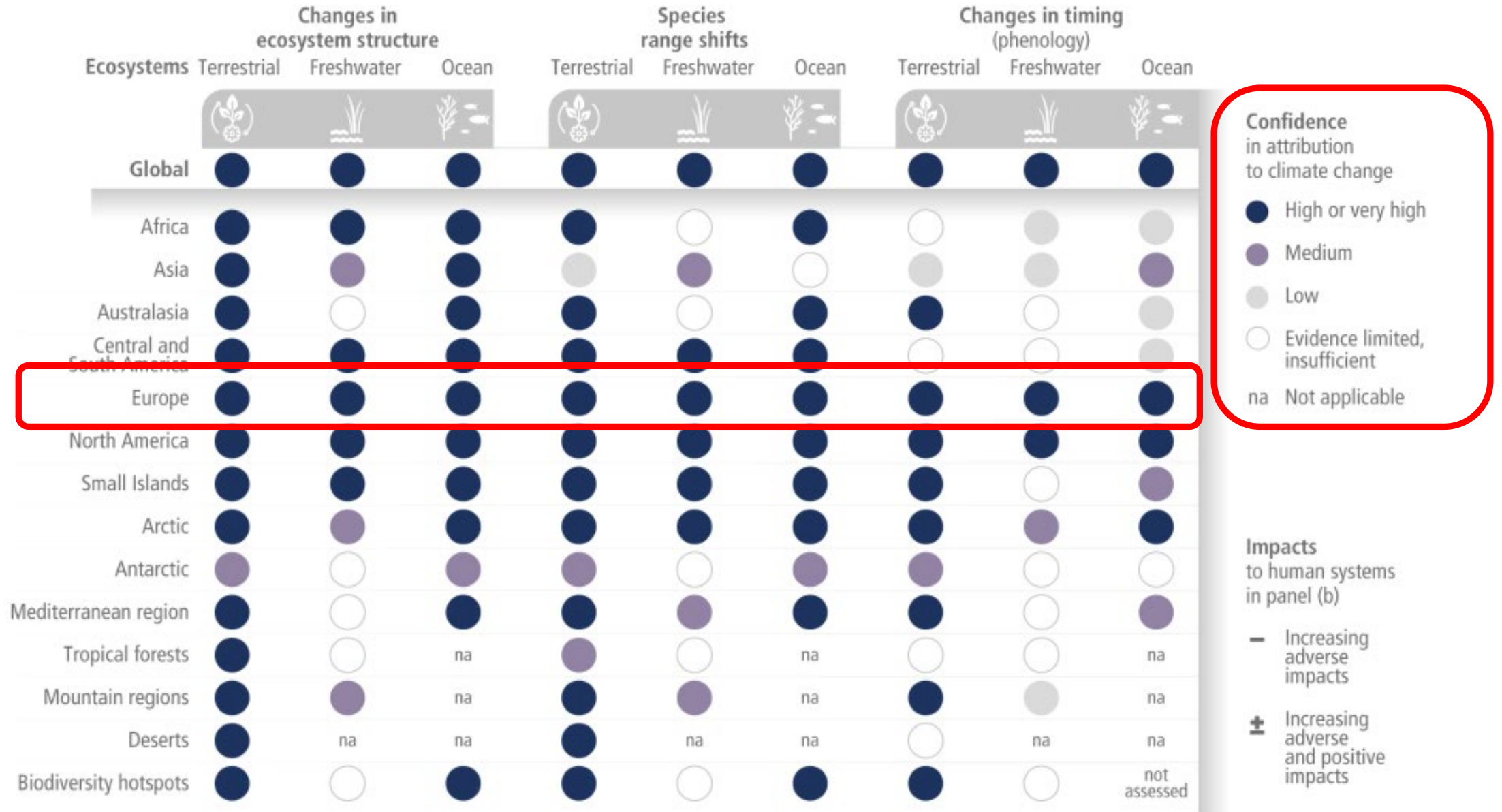
amount in turnover for 2018 by Ireland's ocean economy

34,000 jobs

associated with our ocean economy



(a) Observed impacts of climate change on ecosystems



Our Changing Ocean

“Every bit of warming matters, every year matters, every choice matters”

Extreme Weather Events

A warming ocean fuels storms and extreme events increasing the risks to coastal ecosystems and human settlements.

Global Mean Sea Level

We have already observed sea level rise of 3-10 mm per year around Ireland. We may see changes between 10 cm to 100 cm in the next 80 years.



VERY HIGH CONFIDENCE



HIGH CONFIDENCE

Harmful Algal Blooms of Microscopic Plants

have increased since the 1980s in response to changes in the ocean.

Coastal Communities

are more exposed to rising sea levels increasing the risks of flooding and storm surges.



HIGH CONFIDENCE

The Ocean is Running Out of Breath

A warmer ocean holds less oxygen, which is essential for marine life. Oxygen declined in the ocean by 2% over a period of just 50-years [from 1960 to 2010].



VERY LIKELY

Ocean Acidification

Increased carbon dioxide in the ocean leads to ocean acidification. Ocean acidity has already increased by ~25% in recent decades. This increase is projected to continue by 100 to 150% by the end of this century if carbon dioxide emissions continue to remain high. Coral reefs and shellfish are very sensitive to ocean acidification.



VERY LIKELY

Atlantic Meridional Overturning Circulation is Projected to Weaken

This means less warm water will reach Irish shores and this could change weather patterns.



LIKELY

Ocean Warming

It is likely that the rate of ocean warming has increased since 1983.

A Warmer Ocean Absorbs Less Gases leading to deoxygenation and a lowering of the ocean capacity to absorb human green house gas emissions.

Marine Heatwaves Marine ecosystems are negatively impacted when exposed to sudden high temperatures for 5 days or more, e.g. benthic communities can collapse or fish distribution can change.

Ecosystem Degradation

Climate change impacts marine ecosystems by reducing biodiversity and altering habitats.



HIGH CONFIDENCE

^ Likely

^ Very likely

^ Virtually certain

^ High confidence

^ Very high confidence

<66% probability

<99% probability

>99% probability

Refers to the degree of confidence in being correct

There is high agreement and robust evidence this will occur



Ocean Climate Policy & Government Drivers



Rialtas na hÉireann
Government of Ireland

Climate Status Report for Ireland 2020



Rialtas na hÉireann
Government of Ireland

CLIMATE ACTION PLAN 2023 CAP23

Changing Ireland for the Better



Rialtas na hÉireann
Government of Ireland



epaResearch

EPA Research Report 386
Prepared by MaREI, University of Galway
Editors and Lead Authors: Wanda
Cámaro García, Ned Dwyer

Foras na Mara
Marine Institute

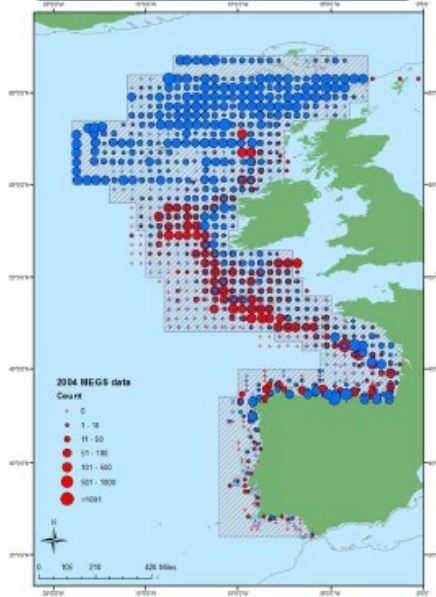


Foras na Mara
Marine Institute

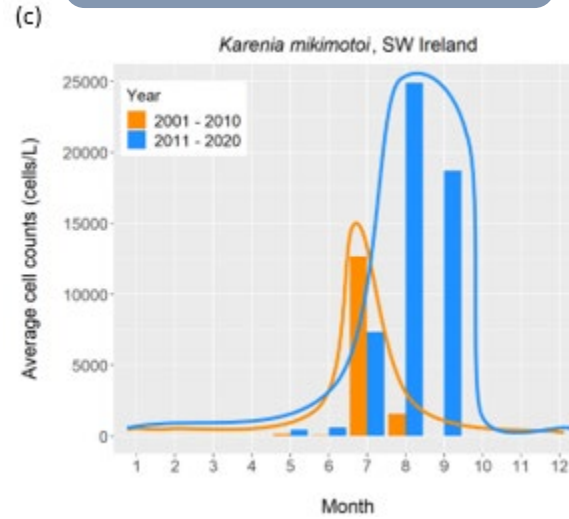


Climate Change Sectoral Adaptation Plan (Seafood)

Fish



Harmful Algae



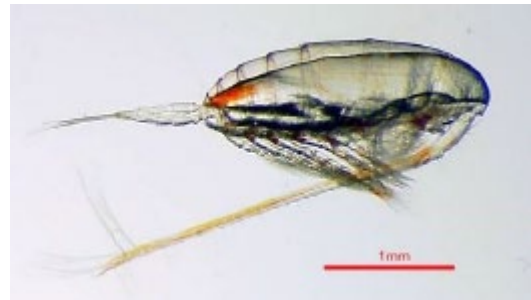
Art & Science



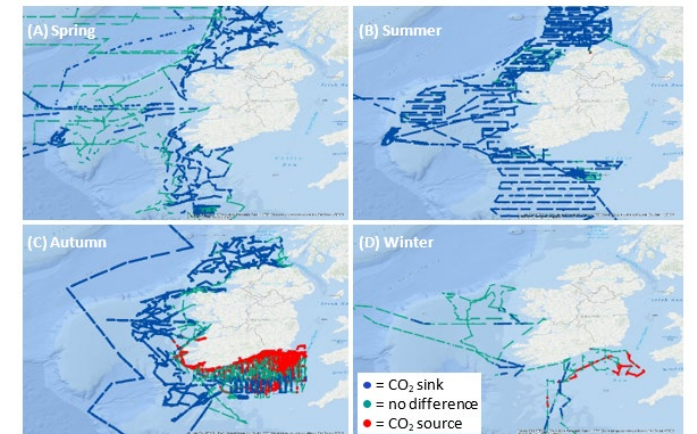
Seafood Infrastructure



Plankton



Ocean Acidification



Irish Ocean Climate & Ecosystem Status Report 2023

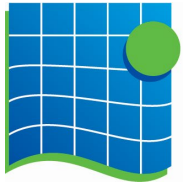
IRISH OCEAN CLIMATE AND ECOSYSTEM

STATUS REPORT
2023



<https://oar.marine.ie/handle/10793/1844>

Irish Ocean Climate & Ecosystem Status Report 2023 - Authors



Foras na Mara
Marine Institute



Maynooth University
National University of Ireland Maynooth



Ollscoil Teicneolaíochta an Atlantaigh
Atlantic Technological University



OLLSCOIL NA GAILLIMHE
UNIVERSITY OF GALWAY



University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath



AN FÓRAM UISCE



Iascach Intire Éireann
Inland Fisheries Ireland



Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin



BirdWatchIreland
protecting birds and biodiversity



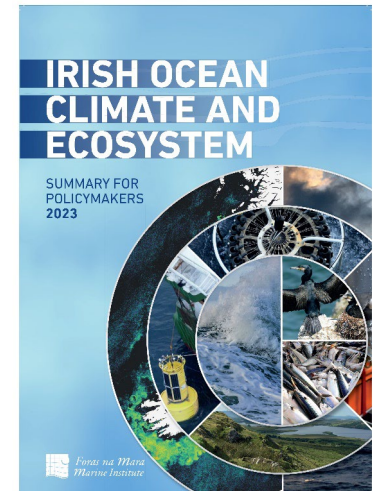
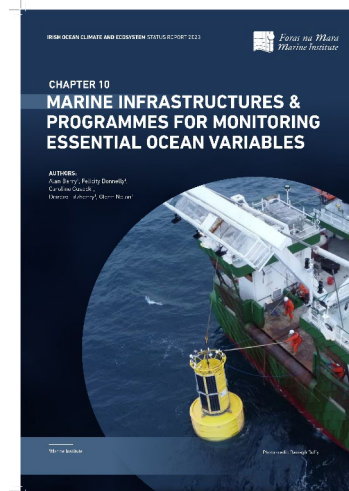
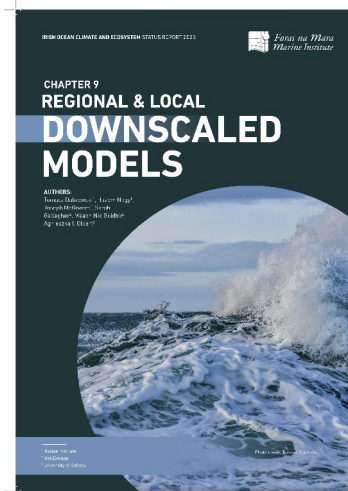
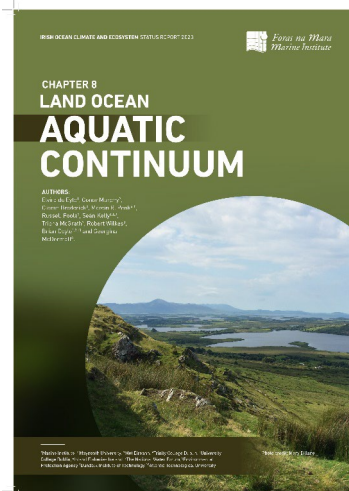
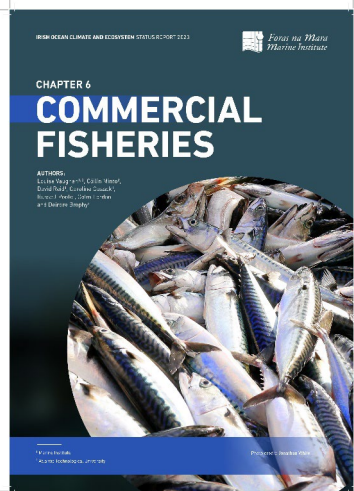
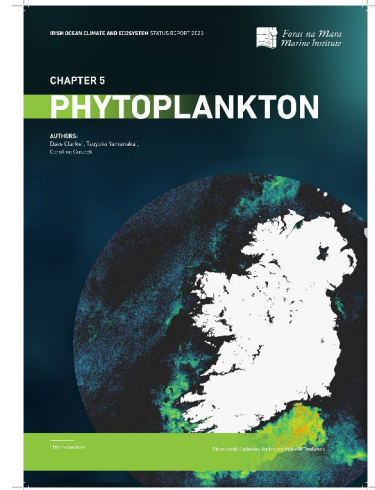
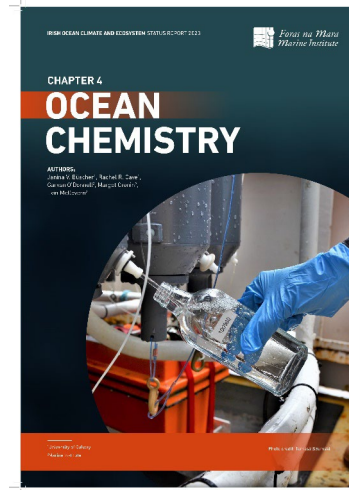
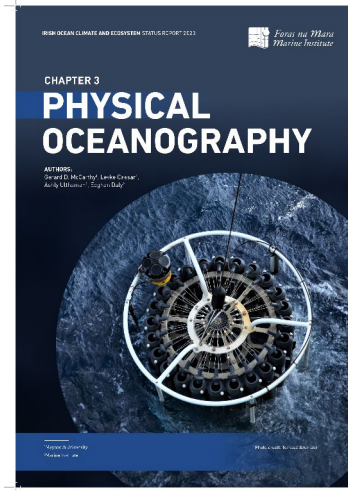
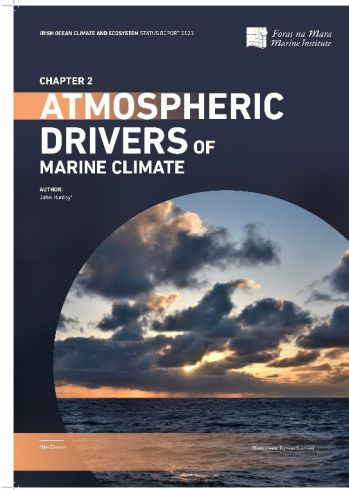
National Parks & Wildlife Service



epa

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Ocean Climate & Ecosystem Status Report 2023 - Structure



Key Findings



CHAPTER 2

ATMOSPHERIC DRIVERS OF MARINE CLIMATE

AUTHOR:
John Hanley¹



¹ Met Eireann

Photo credit: Tomasz Szumski

Atmospheric Drivers

- The ocean and the atmosphere are a **'tightly coupled system'** with heat, momentum and mass continuously exchanged between the two.
- North Atlantic modes of Variability: The North Atlantic Oscillation (NAO) is the leading mode of climate variability in North Atlantic, but we need to look at other modes of atmospheric drivers like the East Atlantic pattern and Scandinavian pattern.

NAO 



NAO 



CHAPTER 3

PHYSICAL OCEANOGRAPHY

AUTHORS:

Gerard D. McCarthy¹, Levke Caesar¹,
 Ashly Ulthaman¹, Eoghan Daly²

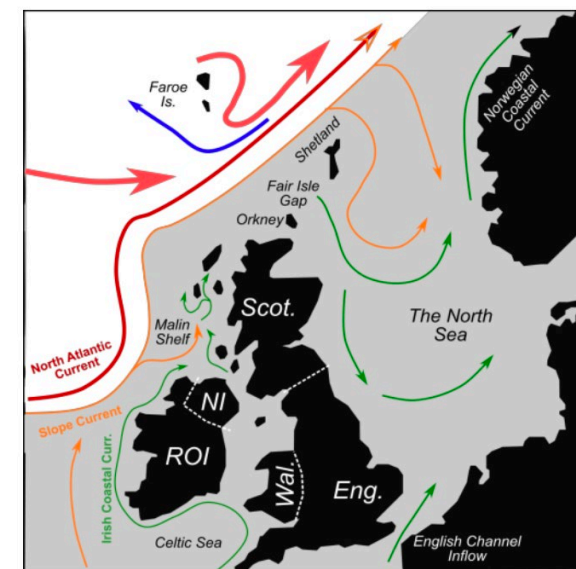
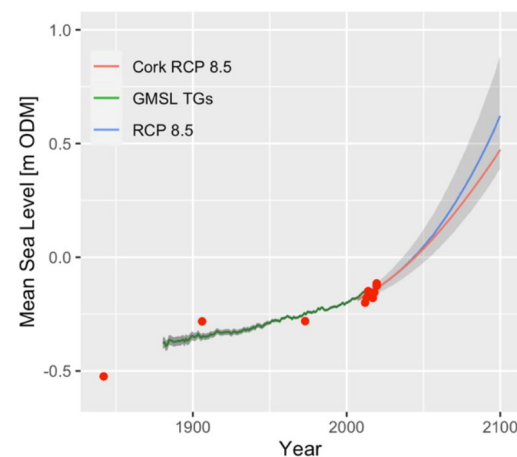


¹Maynooth University
²Marine Institute

Photo credit: Tomasz Szumski

Physical Oceanography

- The Atlantic Meridional Overturning Circulation (AMOC) or Gulf Stream system is key to Ireland's mild climate. **This system is predicted to decline due to climate change** with some proxies indicating this may already have begun.
- Irish waters have warmed since the 1980s and **sea levels continue to rise** with larger sea level rise observed in Cork and Dublin compared to global estimates.



CHAPTER 4

OCEAN CHEMISTRY

AUTHORS:

Janina V. Büscher¹, Rachel R. Cave¹,
Garvan O'Donnell², Margot Cronin²,
Evin McGovern²

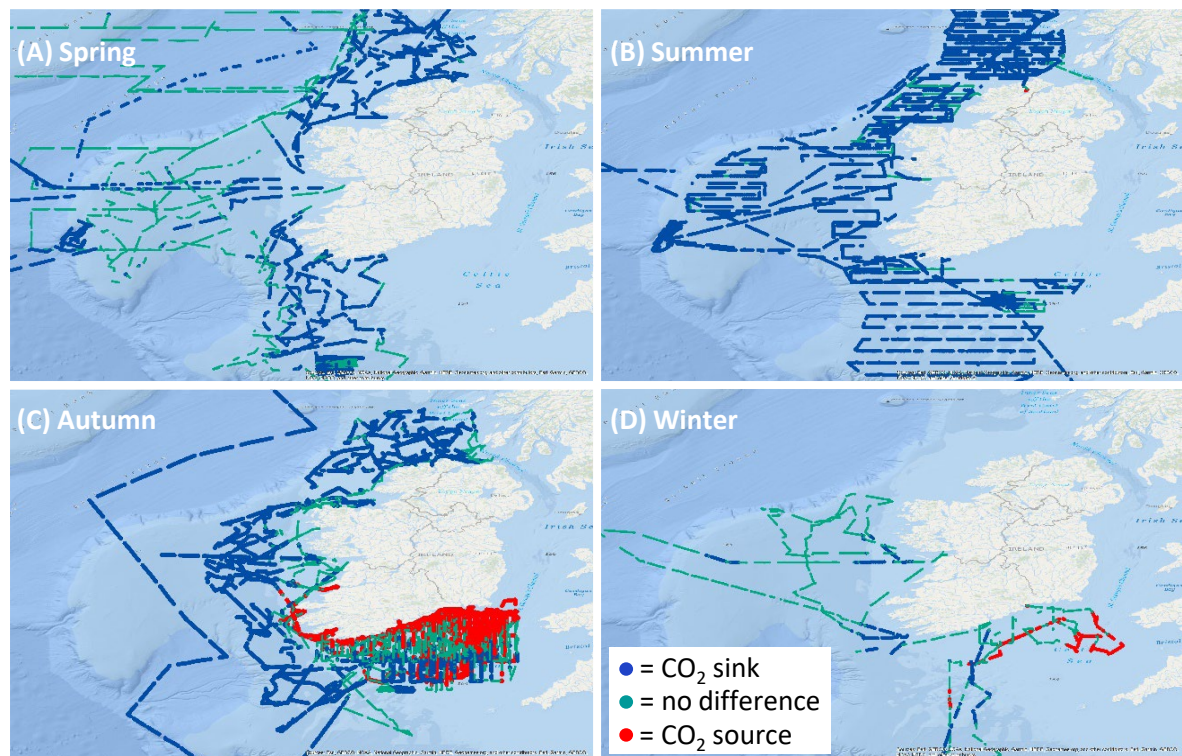


¹University of Galway
²Marine Institute

Photo credit: Tomasz Szumski

Ocean Chemistry

- Irish offshore waters have become more acidic with an overall reduction in pH of 0.02 units per decade.
- Irish waters are generally a CO₂ sink in spring and summer, but some areas may be a source in autumn.



CHAPTER 5

PHYTOPLANKTON

AUTHORS:

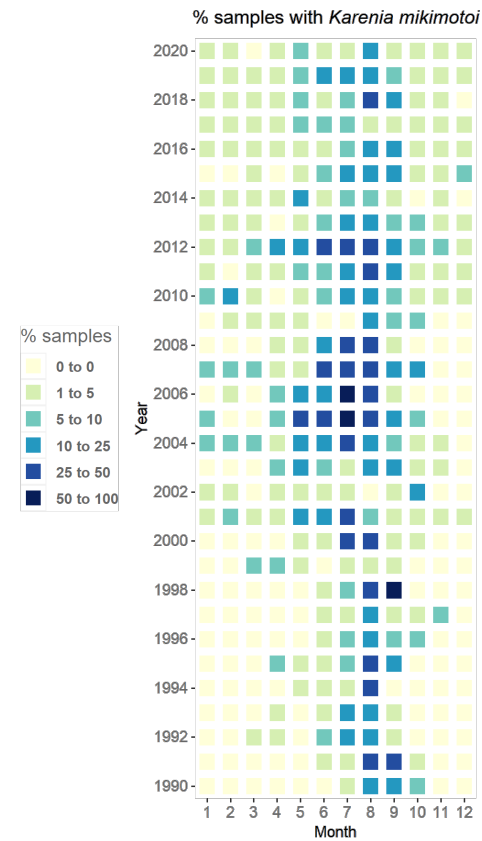
Dave Clarke¹, Tsuyuko Yamanaka¹,
Caroline Cusack¹



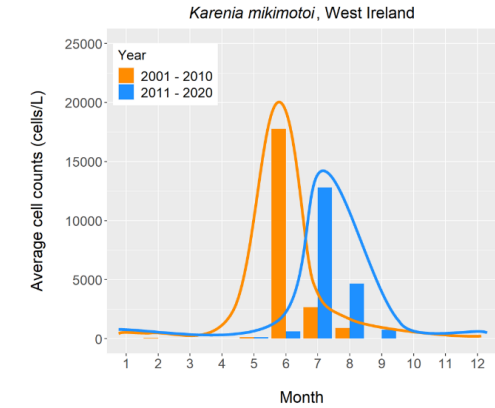
Phytoplankton

- An expansion of the phytoplankton growth season has been observed for some species in Irish waters.

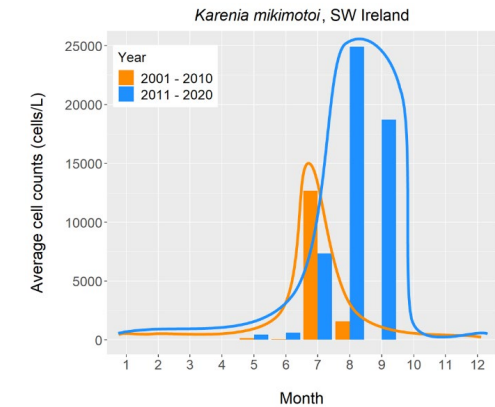
(a)



(b)



(c)



CHAPTER 6

COMMERCIAL FISHERIES

AUTHORS:

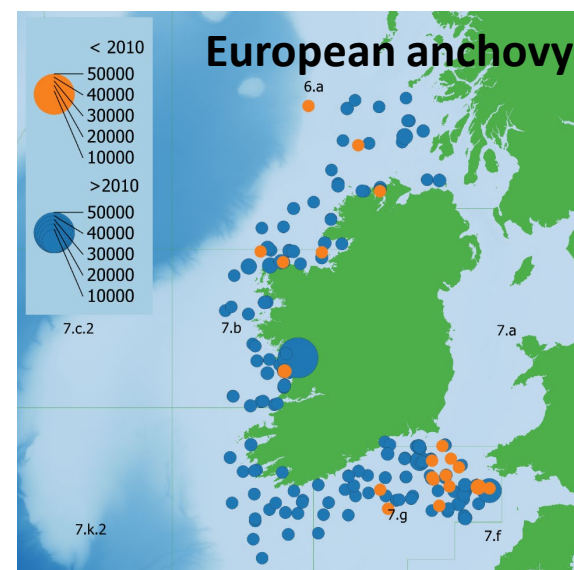
Louise Vaughan^{1,2}, Cóilín Minto²,
 David Reid¹, Caroline Cusack¹,
 Russell Poole¹, Colm Lordan¹
 and Deirdre Brophy²

¹ Marine Institute² Atlantic Technological University

Photo credit: Jonathan White

Commercial Fisheries

- Declines in overexploited stocks may be exacerbated by climate change.
- Disentangling climate effects from other pressures including fishing remains a challenge.
- There is evidence of increasing Lusitanian (warm water) species to the south of Ireland that may allow for new fishing opportunities e.g. boarfish and anchovy.



CHAPTER 7

SEABIRDS

AUTHORS:

Andrew Power¹, Stephen Newton²,
Brian Burke², David Tierney²,
Ian O'Connor¹



¹ Atlantic Technological University

² BirdWatch Ireland

³ National Parks and Wildlife Service

Cormorant (*Phalacrocorax carbo*)
Photo credit: Brian Burke

Seabirds

- Half of seabird species globally have **declining population trends**.
- Eighty nine percent of seabirds affected by climate change are also affected by other threats e.g. overfishing, incidental capture, hunting/trapping and disturbance, **difficult to disentangle the precise effects of each threat**.
- **Populations of Little Terns may be most vulnerable to sea level rise**, as well as species that nest on coastal beaches such as Ringed Plover.
- **Seabird mortality during storms is likely caused by starvation**, as seabirds cannot effectively find prey in these extreme conditions.

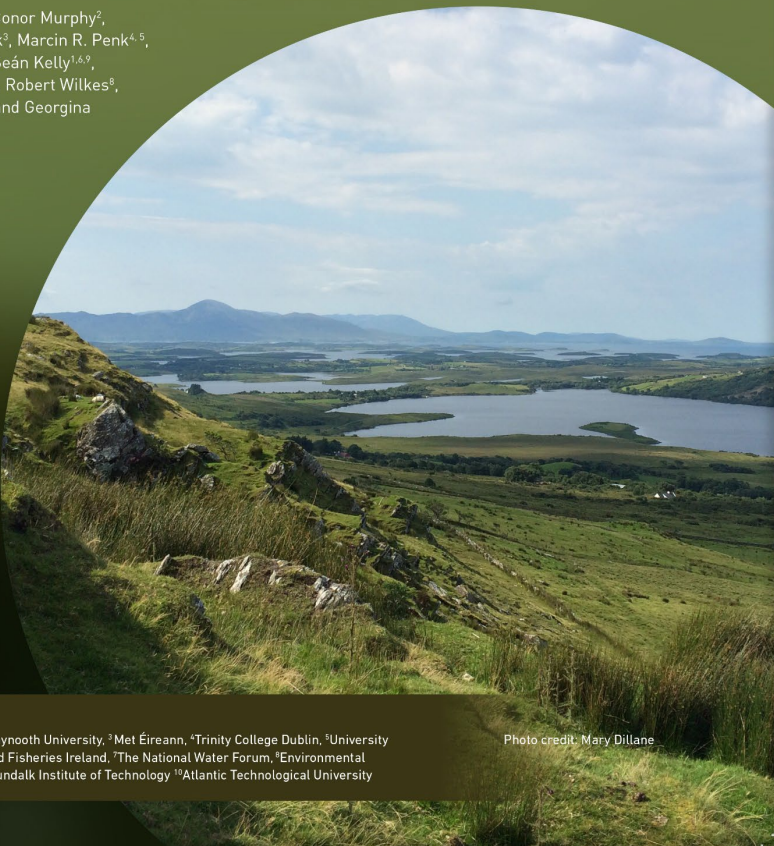
CHAPTER 8

LAND OCEAN

AQUATIC CONTINUUM

AUTHORS:

Elvira de Eyto¹, Conor Murphy²,
Ciaran Broderick³, Marcin R. Penk^{4, 5},
Russell Poole¹, Seán Kelly^{1, 6, 9},
Triona McGrath⁷, Robert Wilkes⁸,
Brian Doyle^{1, 9, 10} and Georgina
McDermott⁸.

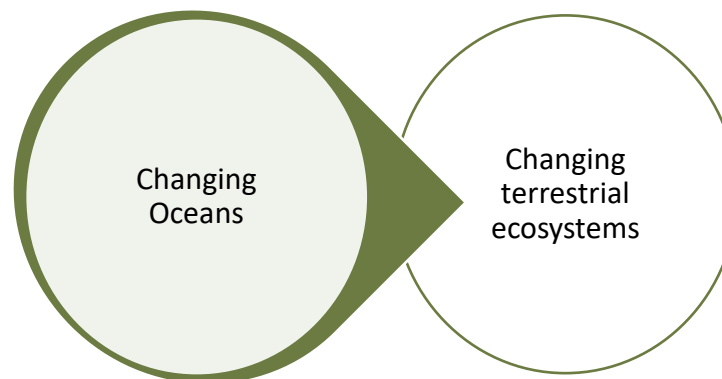


¹Marine Institute, ² Maynooth University, ³ Met Éireann, ⁴Trinity College Dublin, ⁵University College Dublin, ⁶Inland Fisheries Ireland, ⁷The National Water Forum, ⁸Environmental Protection Agency ⁹Dundalk Institute of Technology ¹⁰Atlantic Technological University

Photo credit: Mary Dillane

LOAC

- The return of Atlantic Salmon after one winter at sea have **declined** from almost 1,800 in 1973 to 279 in 2014. Reduced returns have been correlated with **increased water temperatures** and decreased abundance of plankton.



CHAPTER 9

REGIONAL & LOCAL

DOWNSCALED MODELS

AUTHORS:

Tomasz Dabrowski¹, Hazem Nagy¹,
Joseph McGovern¹, Sarah
Gallagher², Méabh Nic Guidhir²,
Agnieszka I. Olbert³

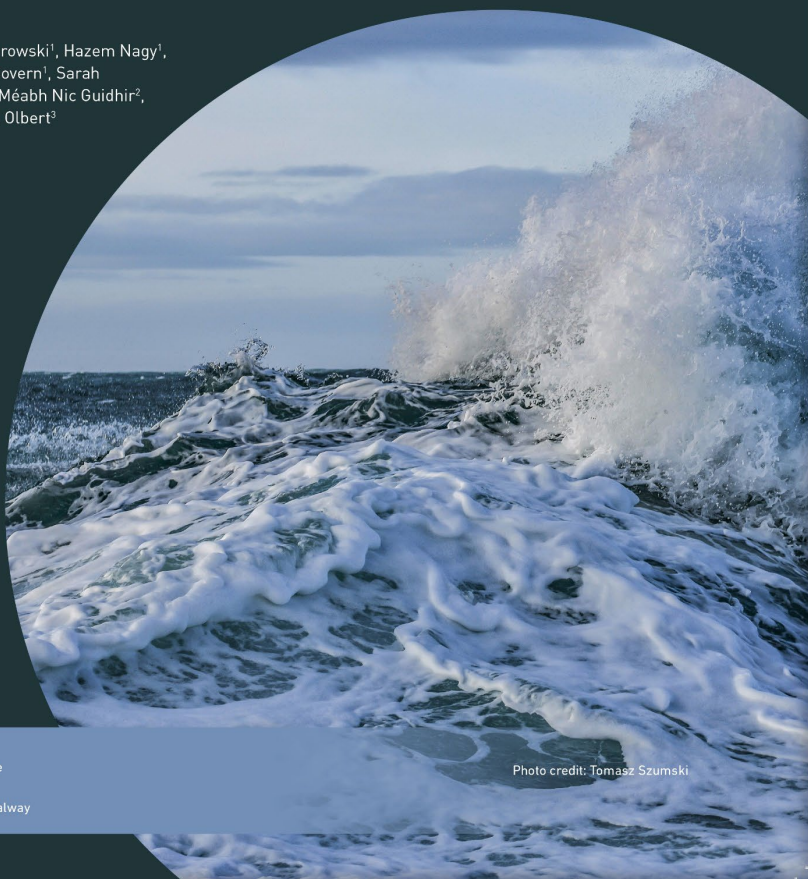
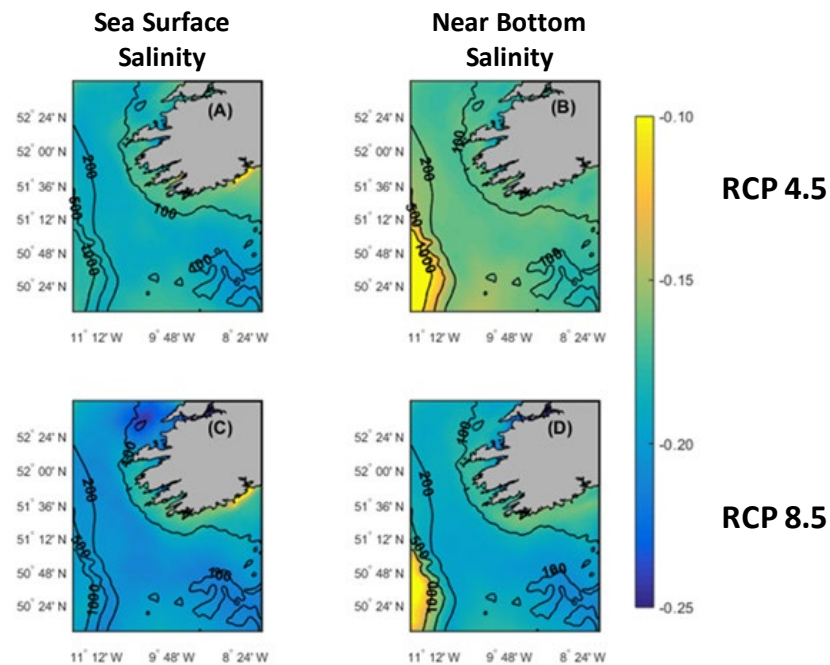


Photo credit: Tomasz Szumski

¹ Marine Institute² Met Éireann³ University of Galway

Modelling

- Significant **wave heights** are projected to decrease, particularly for summer and winter.
- Mean **sea level** for the Irish coast is projected to **increase** by between 25 cm and 1 m depending on the greenhouse gas emissions trajectory considered.
- Projections of the **salinity off southwest Ireland** suggest a **freshening trend** by 2035.



IRISH OCEAN CLIMATE AND ECOSYSTEM

STATUS REPORT
2023



See report for Recommendations
from each chapter



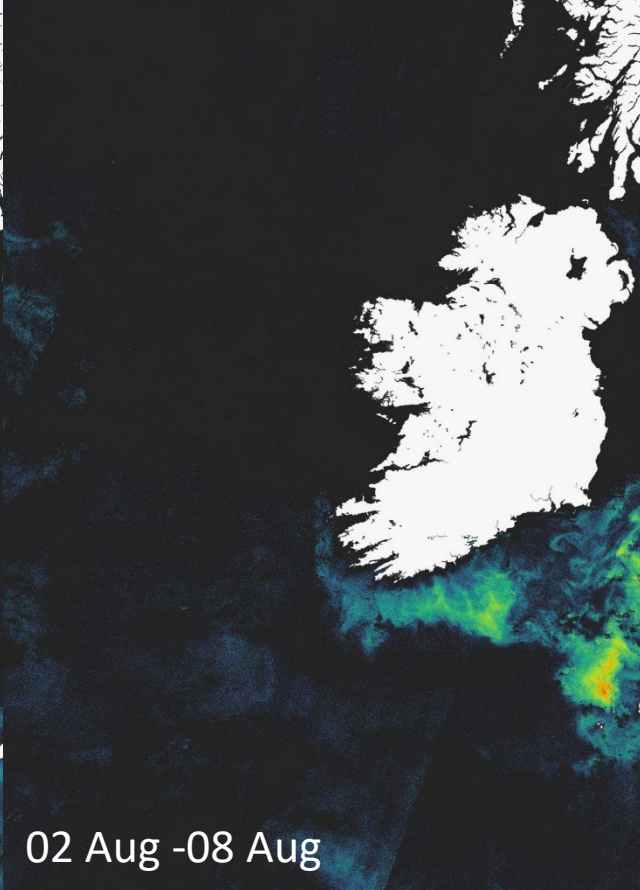
<https://oar.marine.ie/handle/10793/1844>

Next Steps

1. Engagement with Ireland's National Framework for Climate Services.
2. Enhanced digital climate services (co-designed with users).
3. Enhanced communication and outreach on marine climate matters.
4. Engagement with National Climate Action Plans.
5. Continue to gather marine scientific evidence to support climate adaptation and mitigation decisions.

Ongoing Research

Some examples

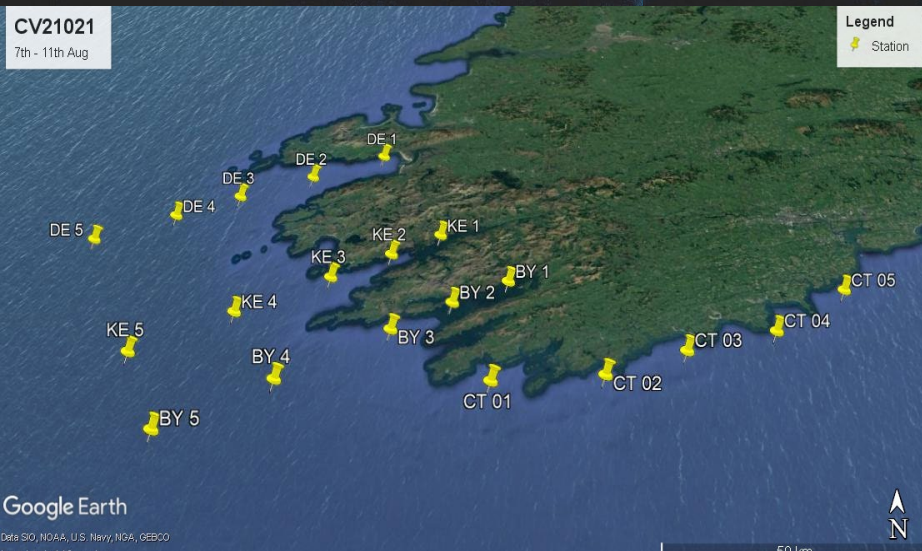


26 Jul - 01 Aug

02 Aug -08 Aug

09 Aug – 15 Aug

16 Aug – 22 Aug



Satellite & the HABscope

7th – 11th August, 2021

Research Survey CV21021



“Extreme Marine Events” Ocean Observing & Forecasting

Bespoke web portal to display oceanographic data and ocean warnings

Essential Ocean Variables: water currents, wind, oxygen, temperature, salinity, pH, chlorophyll, turbidity



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 862626



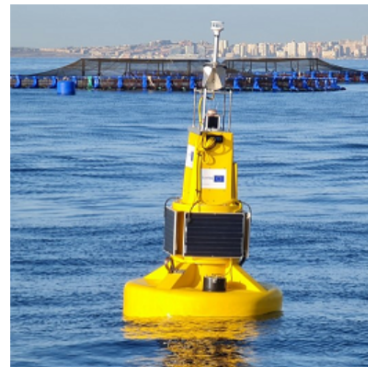
Deenish Island & Southwest of Ireland

In-situ Warnings & Forecasts

Remote Sensing Warnings

In-situ Historical Data

Remote-Sensing Historical Data



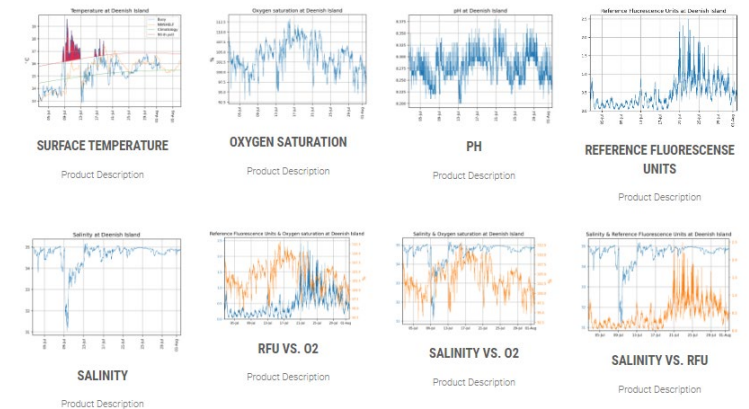
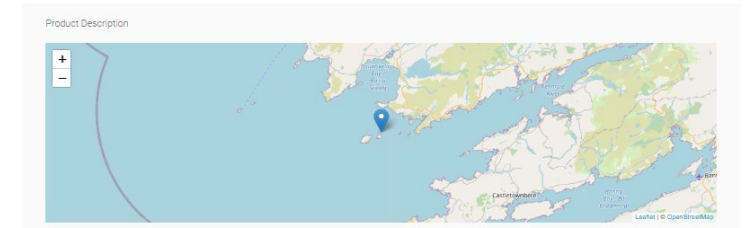
El Campello

In-situ Warnings & Forecasts

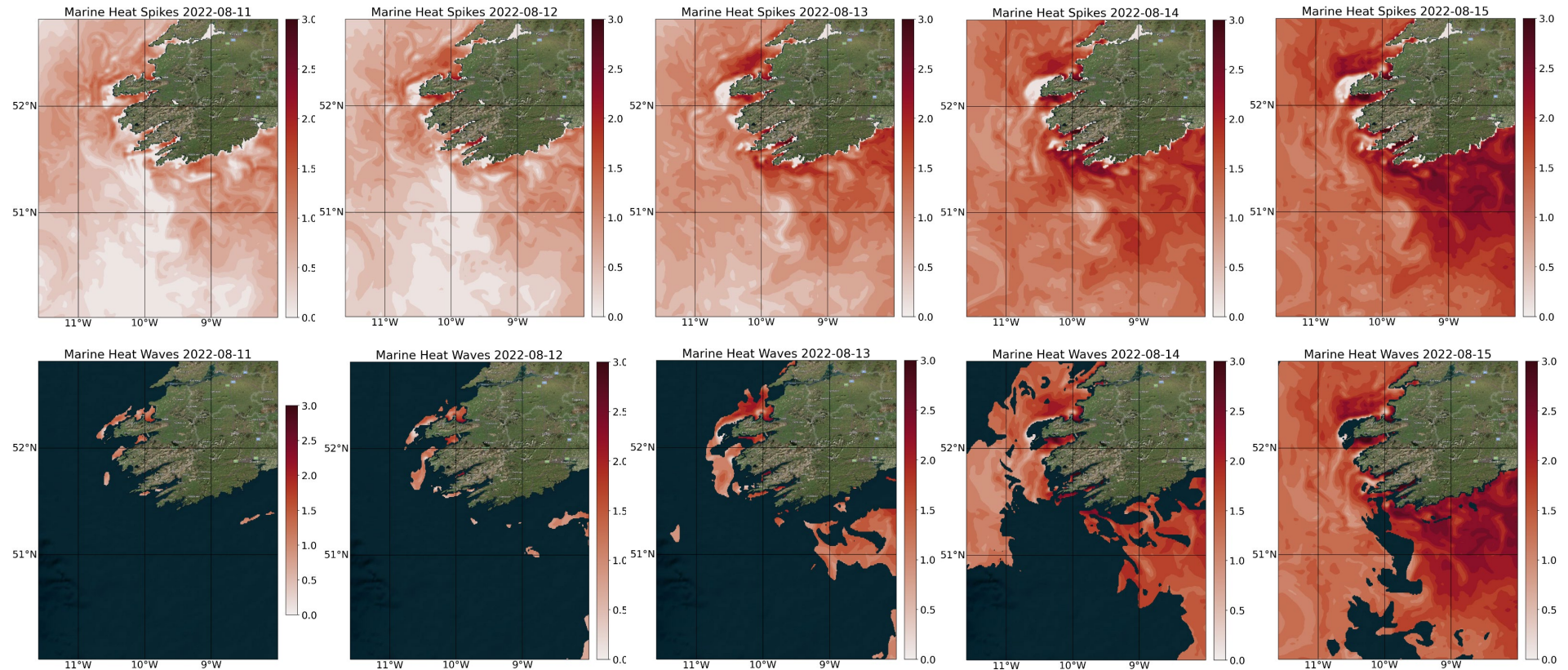
In-situ Historical Data

This is a EuroSea partnership between the Marine Institute, the Spanish National Research Council (CSIC), AVRAMAR, Mowi Ireland (formerly Marine Harvest) and Xylem / Aanderaa Data Instruments. This part of the Marine Observatory work is being developed within the WP6 Ocean Health Demonstrator of the EuroSea project “Improving and integrating the European Ocean Observing and Forecasting System”. This project is funded by the EU Horizon 2020 research and innovation programme under grant agreement No. 862626.

DISCLAIMER. Please, note that this service is currently in pre-operational phase of development. The user assumes the entire risk related to use of information contained in the Irish EuroSea Ocean Observation and Forecasting System. The data is provided "as is," and disclaims any and all warranties, whether expressed or implied, including (without limitation) any implied warranties of merchantability or fitness for a particular purpose.

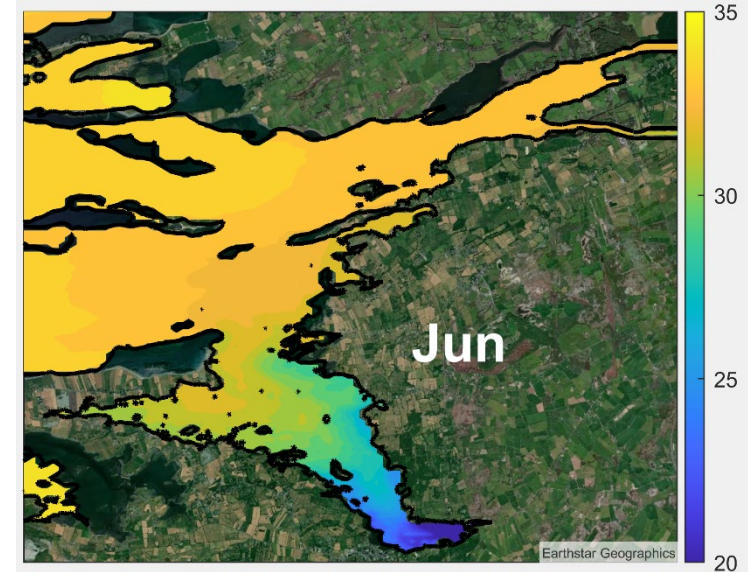
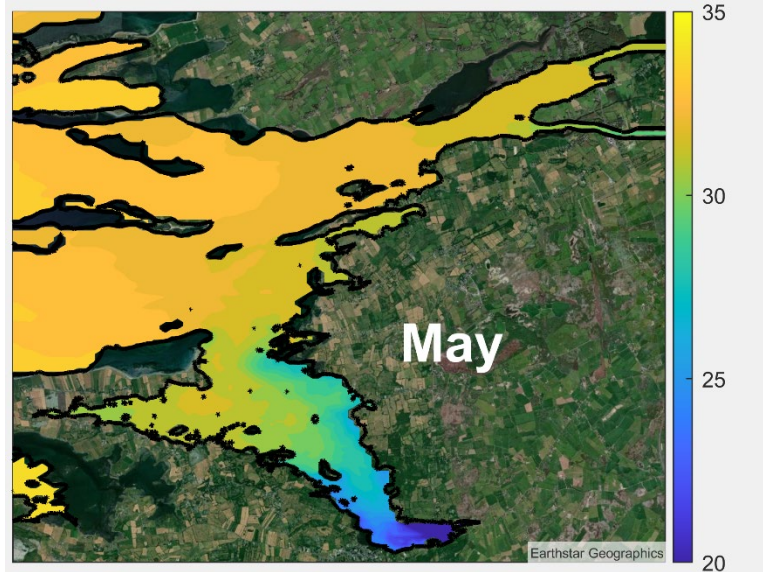
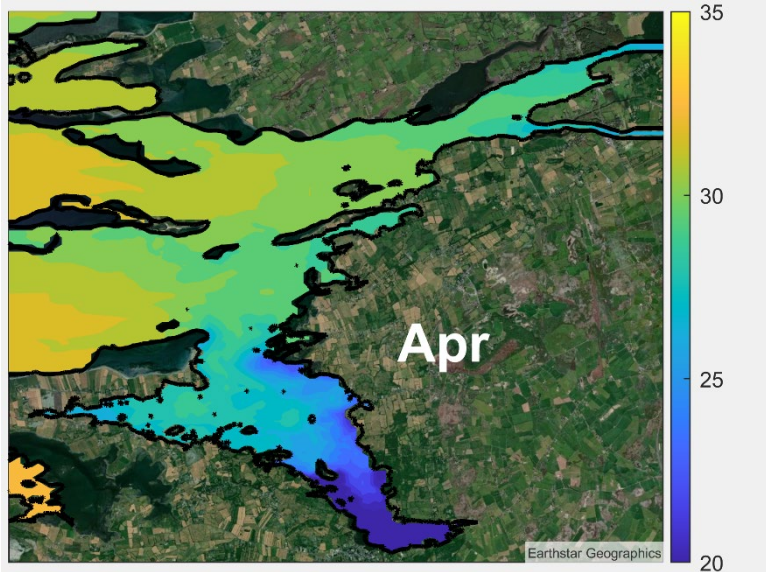
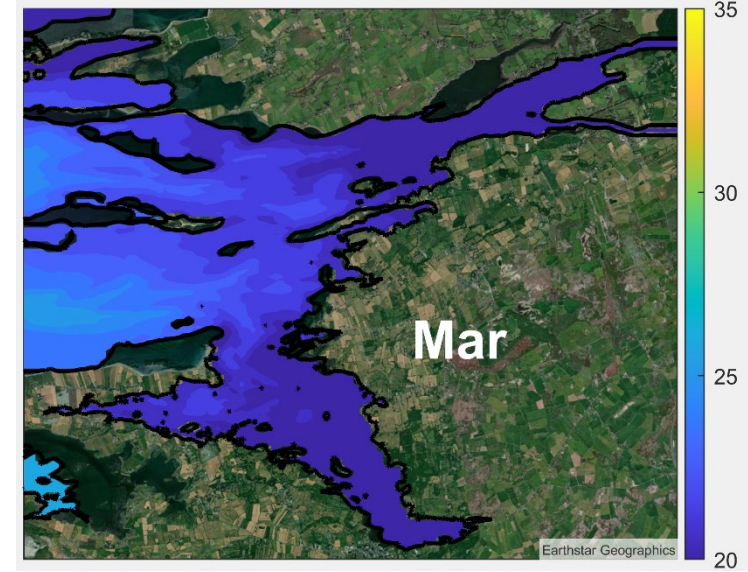
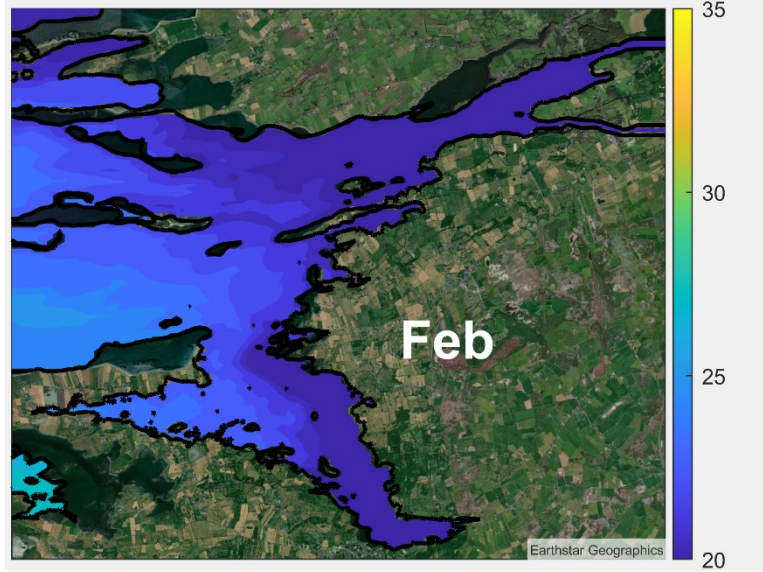
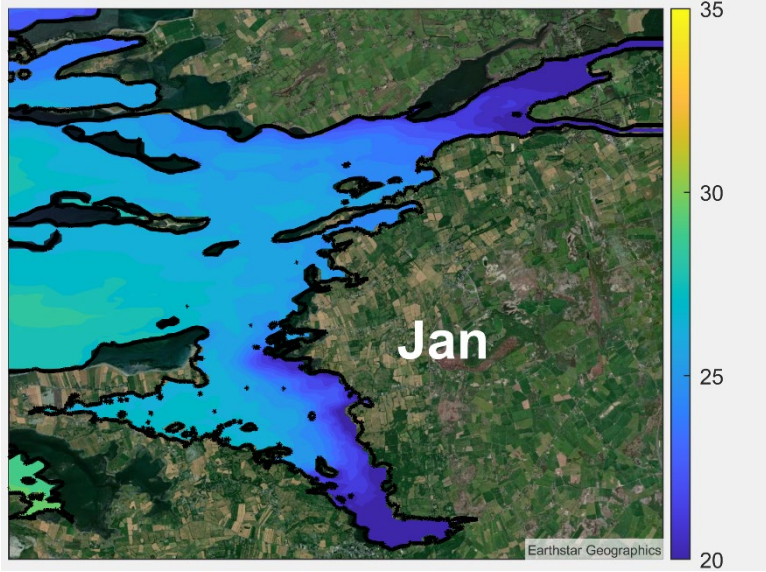


Marine Heat Waves prediction and 2D visualisation



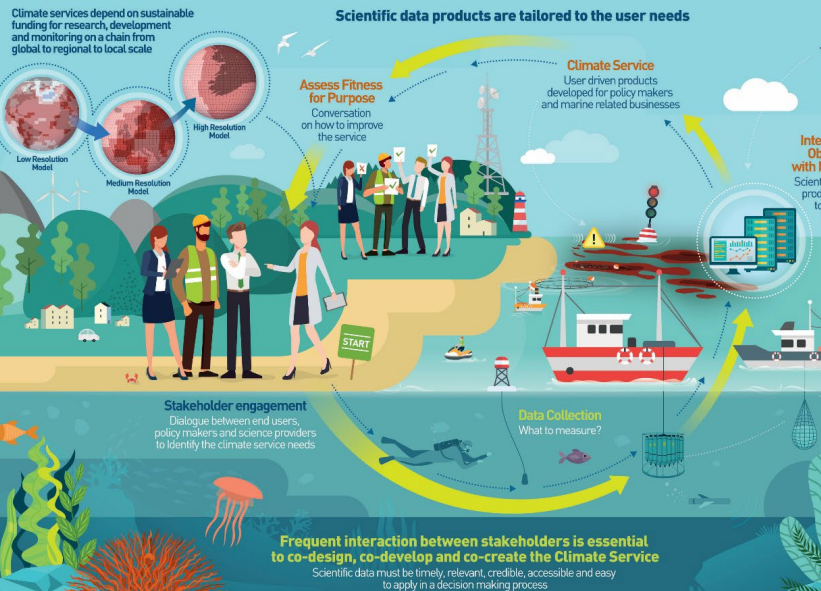
The increasing frequency, duration and intensity of Marine Heat Events, such as Marine Heat Waves (MHWs) are of great concern for a wide range of stakeholders, including aquaculture farmers. Current conditions and forecasts on MHWs are provided as a 2D visualization maps, highlighting the affected areas.

Salinity Distribution: Oyster Cultivation



Informing Local Authority Staff

Climate Services provide information to help people and organisations make climate smart decisions



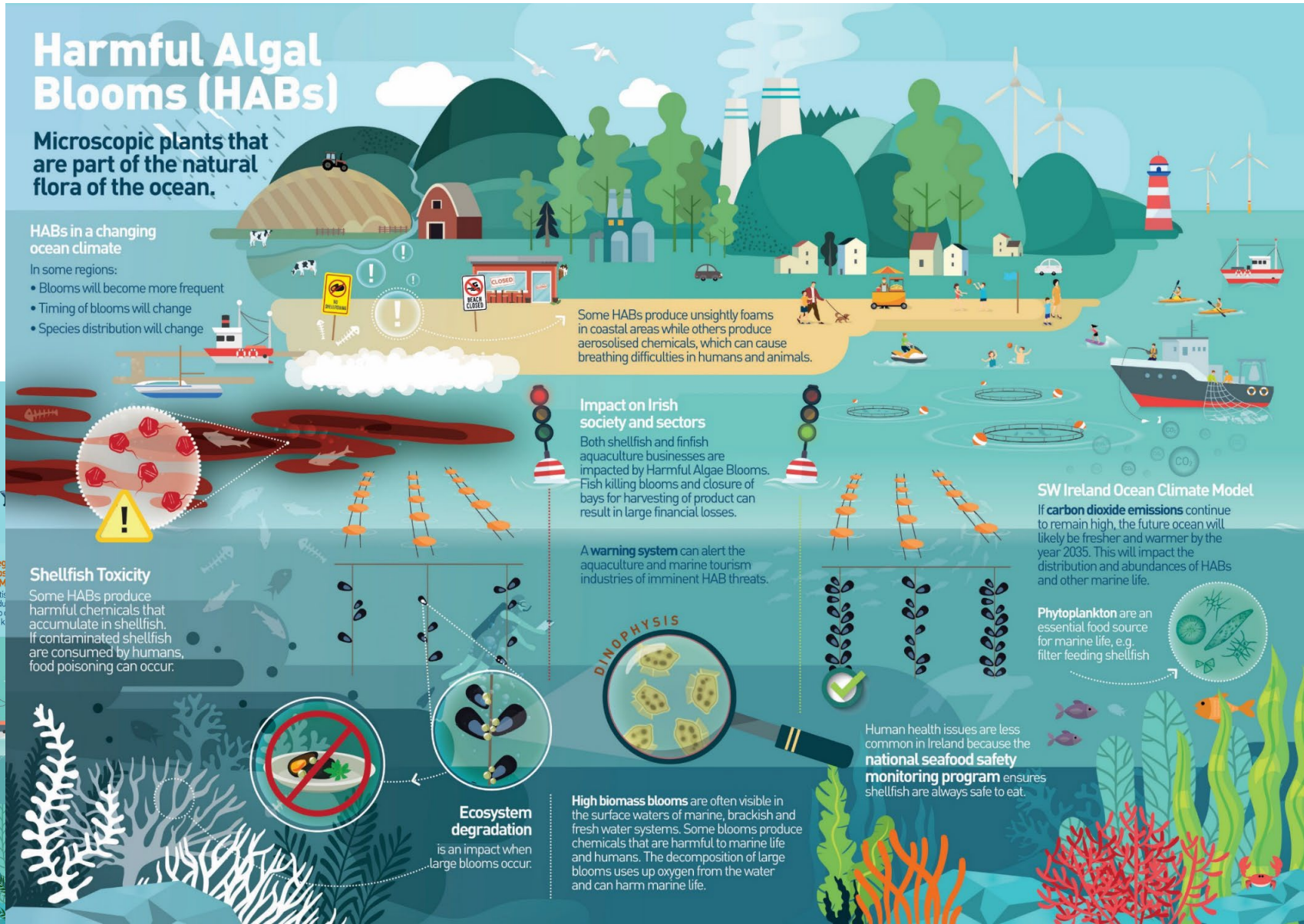
Harmful Algal Blooms (HABs)

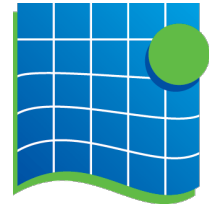
Microscopic plants that are part of the natural flora of the ocean.

HABs in a changing ocean climate

In some regions:

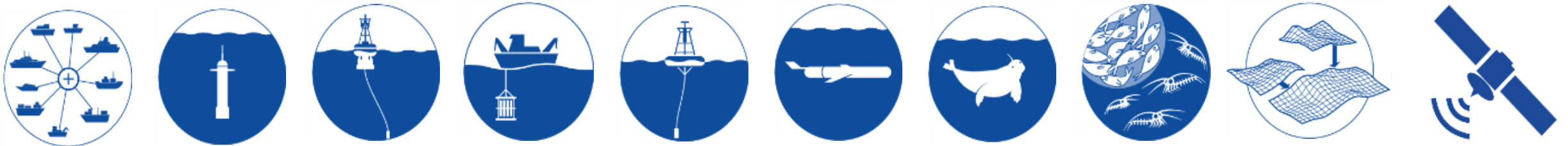
- Blooms will become more frequent
- Timing of blooms will change
- Species distribution will change





Foras na Mara
Marine Institute

Thanks for your attention



Sustained ocean observations, are vital for sustainable development