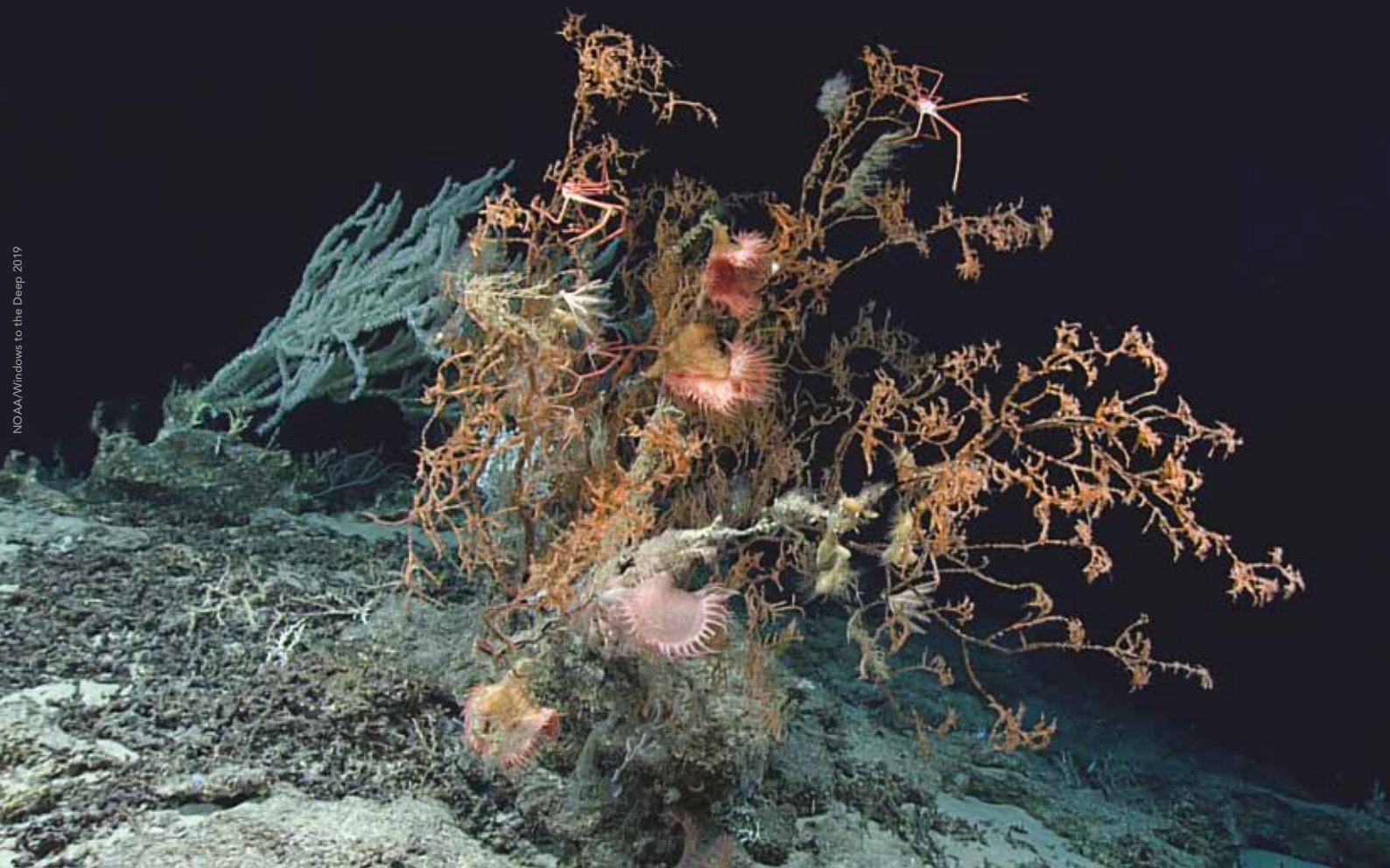




iAtlantic
INTEGRATED ASSESSMENT OF ATLANTIC
MARINE ECOSYSTEMS IN SPACE AND TIME

*How will global change
affect marine life?*

*Which Atlantic ecosystems
are most at risk?*



An ocean under pressure

The ocean faces enormous challenges: climate change is affecting marine ecosystems that are already stressed by habitat destruction, pollution and overexploitation. Changes are apparent in seawater circulation patterns, temperature, acidity and oxygen levels - all of which have consequences for marine ecosystems.

Over the next century, the magnitude and rates of environmental change in the deep and open Atlantic Ocean are expected to be faster and more severe in some areas than others, and may be further exacerbated by human activities. But we know very little about exactly where, or when, the worst impacts of a changing ocean will be seen.

iAtlantic is an EU-funded international research programme undertaking an ocean-wide approach to understanding the factors that control the distribution, stability and vulnerability of ecosystems in the Atlantic Ocean. Our work will determine the tipping points - the points of irreversible change - for deep and open-ocean ecosystems, which drivers are most crucial in propelling ecosystems towards those tipping points, and what factors influence and support ecosystem resilience to environmental change.

“Environmental change is affecting every corner of the planet, from mountaintops to the deep sea

iAtlantic is a multidisciplinary research programme seeking to assess the health of deep-sea and open-ocean ecosystems across the full span of the Atlantic Ocean”

A health check for Atlantic ecosystems

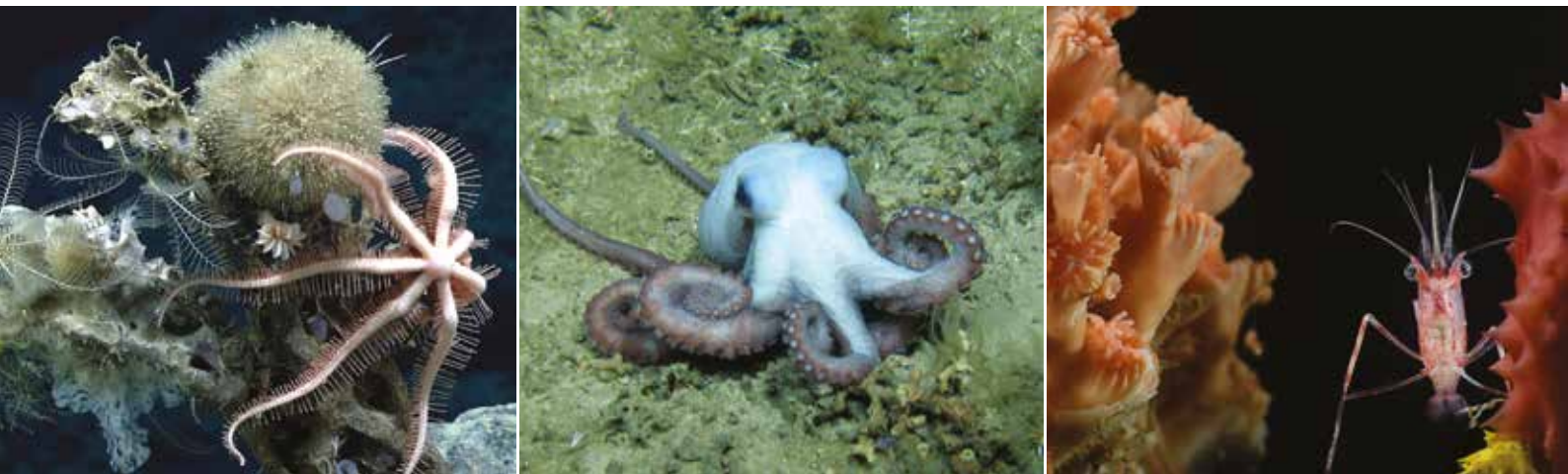
To assess the status of Atlantic ecosystems, we need to know more about how they are connected and distributed, what functions they perform, and how stable they have been over time. All this requires the collection of new data, but also the development of innovative approaches so that local and regional observations can be scaled up to address questions at the ocean basin scale.

To do this, iAtlantic is aligning deep-ocean observing capacities in the north and south Atlantic, which will provide accurate and detailed insights into ocean circulation in the past, present and future at a range of spatial and temporal scales. The latest marine robotics and imaging technology are being used to develop predictive mapping tools to advance our understanding of how deep-sea species and habitats are distributed across the Atlantic basin. And a

detailed look back at how life in the ocean has varied in the past – using ecological timeseries and genomic data – is helping us understand the causes and triggers of ecosystem change. In today's ocean, the pressures on marine life come from many sources, and a key part of our work is to determine how human activities impact the functioning and health of ecosystems, and what synergistic or cumulative effects occur when multiple stressors are at play.

Together, all this new information will provide an unprecedented view of the impacts of global change on Atlantic ecosystems, allowing us to identify key drivers of ecosystem change and determine which areas of the Atlantic Ocean are most vulnerable to the effects of sustained, increasing and multiple pressures.

Below from left: Seastars, crinoids and coral make their home on a dead sponge skeleton at Castle Rock Seamount (image courtesy NOAA Ocean Exploration 2021, North Atlantic Stepping Stones expedition); A deep-sea Muusoctopus resting among coral reef detritus on the Hebrides Terrace Seamount (image courtesy U.Edinburgh/Changing Oceans Expedition/JC073); Up close and personal with shrimp and coral during the IceDiva mission to the North Atlantic in January 2021 (image courtesy Solvin Zankl, IceDiva/SO280 expedition).



iAtlantic has 5 key objectives:



Align and standardise ocean observing in the north and south Atlantic to enable short, medium and long-term assessments of ocean circulation

Map deep- and open-ocean Atlantic ecosystems at **local, regional and basin scales**

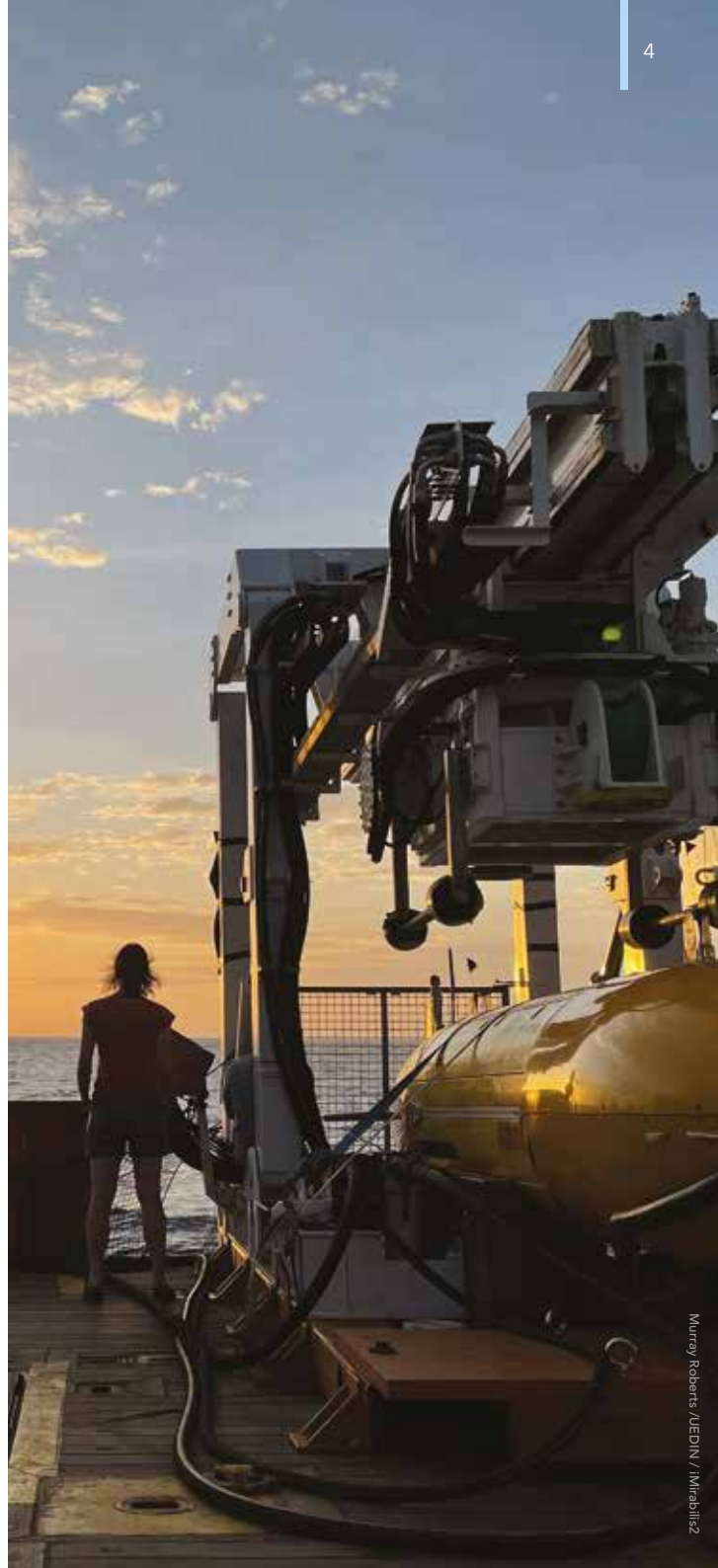


Assess the **stability, vulnerability and tipping points** of these ecosystems in relation to a range of stressors

Build and enhance **human and technological capacities** for cost-effective cooperation and planning across the Atlantic



Work with industry, regulatory and governmental stakeholders to use this knowledge in support of a **sustainable Blue Economy**



An Atlantic-wide approach...



iAtlantic's work spans the full scale of the Atlantic basin, from the tip of Argentina in the south to Iceland in the north, and from the east coasts of Canada and Brazil to the western margins of Europe and Africa. With such a large research challenge in front of us, international collaboration between scientists throughout the Atlantic region is critical to the project's success: sharing of expertise, equipment, infrastructure, data and personnel is at the forefront of iAtlantic's approach.

To achieve our goals, we focus our ecosystem assessment efforts on 12 key areas of the deep and open Atlantic that have international conservation significance and/or are of interest to Blue Economy and Blue Growth sectors (see map, right). Seagoing expeditions in these 12 areas - and beyond - will provide vital data to help identify the ecosystems most at risk from environmental change in the deep and open ocean.

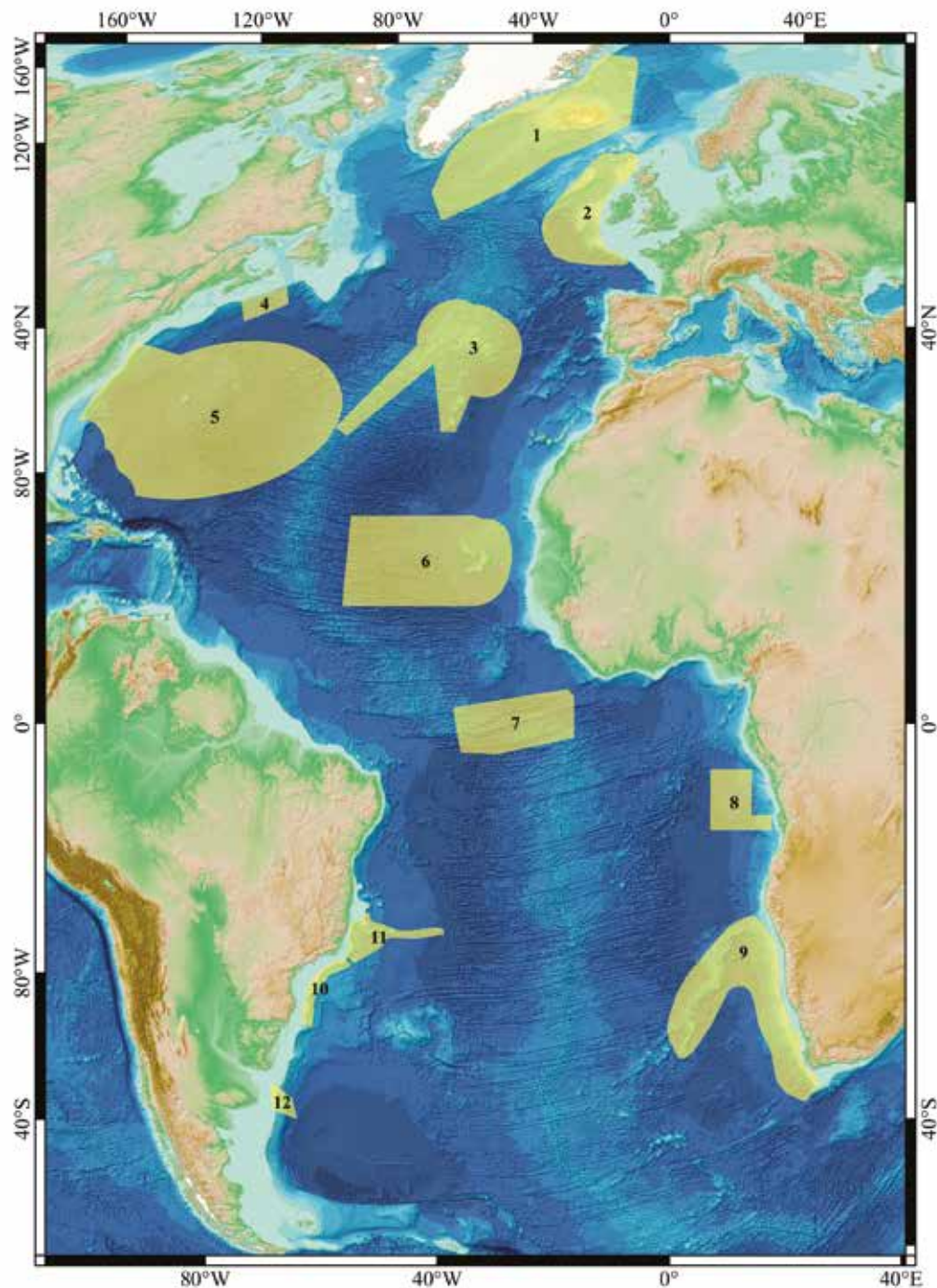
...using cutting-edge technology and innovation

Drawing on a multinational fleet of research vessels and the latest marine technology and instrumentation, scientists of all disciplines from across the partnership are involved in these seagoing missions. Capacity building - both technological and human - is a key component of every expedition, and the sharing of equipment, personnel, data and expertise is essential in maximising our ability to make the necessary observations and measurements.

Innovative approaches will be used to scale up the observations taken at local and regional levels in order to address questions at the ocean basin scale. Development of eDNA water column sampling techniques (right) allow us to assess biodiversity over a large area; automated image analysis, machine learning algorithms and species distribution modelling greatly expand our view of the distribution of marine life and habitats across the Atlantic, and novel *in situ* and *ex situ* experiments allow us to directly measure ecosystem response to changing environmental conditions.



Murray Roberts/UEDIN/iMirabilis2



The iAtlantic study areas

The 12 iAtlantic study areas are shown as numbered yellow shapes.

- (1) Subpolar Mid-Atlantic Ridge (MAR) open-ocean ecosystem off Iceland;
- (2) Abyssal plain and deep-sea coral banks from the Rockall Trough to the Porcupine Abyssal Plain;
- (3) Deep-sea coral and hydrothermal vent ecosystems, central MAR;
- (4) Deep-sea canyons and open-ocean ecosystem, NW Atlantic;
- (5) Subtropical open-ocean ecosystem of the Sargasso Sea;
- (6) Eastern tropical North Atlantic, Cabo Verde;
- (7) Equatorial deep/open ocean fracture zones;
- (8) Continental slope, margin and cold seep ecosystems - Angola to the Congo Lobe;
- (9) Abyssal plains and deep-sea ridge ecosystems of the Benguela Current from the Walvis Ridge to South Africa;
- (10) Deep-sea continental slope, banks and cold seep ecosystems off Brazil;
- (11) Vitória-Trindade Seamount Chain off Brazil;
- (12) Deep-sea coral banks in the Malvinas Upwelling Current off Argentina.

Ocean circulation: connecting life, driving change

Ocean circulation is one of the most fundamental life-support systems in the ocean, providing habitat, food supply, oxygen and warmth to marine life, as well being the essential vector that allows animal populations to connect and migrate. Observational instruments moored deep in the North and South Atlantic continuously measure the chemical and physical properties of seawater, so that we can monitor the flow of heat, nutrients and oxygen around the ocean. iAtlantic has improved our capability in measuring this circulation by enhancing the observing arrays at the northern and southern boundaries of the Atlantic. Data from these arrays – along with other in situ measurements

and satellite observations – feed into computer models that enable us to visualise ocean circulation patterns and how they are affected by changing environmental conditions.

Ocean models allow us to look both backward and forward in time in order to understand what drives changes in ocean circulation, and what the environmental and ecological consequences of those changes might be.

Recent scientific research shows that the Atlantic Meridional Overturning Circulation (AMOC) – the major conveyor belt of ocean circulation in the Atlantic – is becoming weaker, and is currently at its weakest state for 1600 years. By the next century, climate change impacts on the AMOC will have affected much of the deep and open-ocean Atlantic, altering not only patterns of water temperature and salinity, but also the carbonate chemistry and the distribution of oxygen. This could radically impact marine ecosystems from the bottom of the food chain to the top ocean predators.

If we can accurately predict future changes in ocean circulation – particularly in response to a warming climate – we can assess how those changes might affect marine life.

Mapping Atlantic ecosystems

To understand how marine ecosystems might be affected by changes in the ocean, we first need to know where they are located. Distribution of life on the deep seafloor is controlled by many factors, including seafloor topography, water depth, substrate, temperature, salinity, oxygen, and food availability. As global change accelerates, environmental changes may trigger shifts in ecosystem distribution as different parts of the ocean become more or less optimal for different species to thrive – or even survive.

iAtlantic is mapping the distribution of ecosystems in the deep- and open-ocean at a range of scales. Marine autonomous and robotic vehicles, coupled with new sensor technology, now give us the ability to survey and image large areas of the deep-sea without the need for labour-intensive manual sampling. Whilst we cannot map the entire Atlantic Ocean basin and every ecosystem within it, we are combining new information from these robotic technologies with existing data to map ecosystems and habitats at basin-wide, regional and local scales.

New mapping data are processed using innovative artificial intelligence, automated image analysis and machine learning. Predictive habitat modelling techniques are applied to extrapolate biodiversity observations up to regional and global scales, enabling us to expand our understanding of ecosystem distribution, status and resilience from local to full Atlantic scale.

Right, from top: ROV Luso goes to work offshore Cabo Verde during the iMirabilis2 expedition (image courtesy Kelsey Archer Barnhill, UEDIN). Inside the ROV control room aboard RV Sarmiento de Gamboa during iMirabilis2 (image courtesy Murray Roberts/UEDIN). Recovering the multicorer aboard RV Meria S. Merian during the MetalML/MSM96 expedition (image courtesy Nico Froehberg).



Understanding how ecosystems change through time

In today's ocean, ecosystems are subject to stresses from multiple sources, including environmental change as a result of natural variation, the effects of climate change, and increasing human activities in the ocean. Distinguishing between ecosystem responses to natural environmental variability and those triggered by external pressures is a significant challenge, but is critical in order to manage our ocean-based activities in a responsible and sustainable manner.

iAtlantic is using long-term records of life in the ocean (known as timeseries data) to examine how it has varied over time. By combining that data with our knowledge of how ocean circulation has changed in the past, we can analyse the relationships between climatic and biological change in the ocean and identify the signals of permanent ecosystem change.

Human activities such as fishing and pollution are also putting pressure on Atlantic ecosystems. A range of novel experiments are helping us untangle the effects of stressors associated with climate change and those linked to direct human impacts, and to determine the synergies between them.

iAtlantic aims to understand the stability and resilience of deep-sea ecosystems under a range of different pressures, which ecosystems are most vulnerable to change, and where the tipping points – the points of irreversible change – lie. We will produce maps illustrating where climate-based predictions of ocean change will likely result in significant ecosystem shifts and tipping points being reached. Identifying areas at greatest risk will assist ocean managers to better plan monitoring and mitigation measures as the likelihood of ecosystem change increases.

Below, from left: Venus flytrap anemone, New England Seamount Chain (image courtesy NOAA Ocean Exploration/2021 North Atlantic Stepping Stones); Scavengers feast on mackerel bait lowered on a camera lander, offshore Cabo Verde, August 2021 (image courtesy Prof. Andrew Sweetman, Lyell Centre/Heriot-Watt University/iMirabilis2 expedition); A humpback whale breaching off the coast of Bermuda (image courtesy Andrew Stevenson, Whales Bermuda).



Science to support a healthy, sustainable ocean

iAtlantic places capacity building at the core of its mission. Alongside a significant cohort of early career researchers who collectively form the community of iAtlantic Fellows, an extensive capacity building programme optimises the learning opportunities provided by the project's many scientific activities. This programme includes hands-on capacity development at sea, instrumentation and technology transfer, collaborative development of analytical techniques and data interpretation, and the transfer of knowledge to the wider Atlantic stakeholder community and policy makers.

The ultimate aim of iAtlantic's research is to be able to provide the necessary relevant information and tools to support competent authorities in the development of integrated, sustainable management decisions and practices at appropriate scales. We will combine project data with existing biogeographic and human-use data to generate maps of how biodiversity and multiple stressors interact in the Atlantic, illustrating the current and future projected changes in status of deep- and open-ocean ecosystems throughout the Atlantic

We work with a broad range of stakeholders from industry, regulators, governments and conservation organisations to use this knowledge in support of a sustainable Blue Economy, helping to ensure that the Atlantic can thrive both ecologically and economically. Ultimately, iAtlantic aims to deliver knowledge that is critical for responsible and sustainable management of Atlantic Ocean resources in an era of unprecedented global change.

We are iAtlantic



iAtlantic
INTEGRATED ASSESSMENT OF ATLANTIC
MARINE ECOSYSTEMS IN SPACE AND TIME

Our partners



Associate partners



www.iatlantic.eu
i-atlantic@ed.ac.uk
 iAtlanticEU



iAtlantic is part of the All Atlantic
Ocean Research Alliance Flagship
**BUILDING AN ALL ATLANTIC
OCEAN COMMUNITY**
Implementing the Belém Statement

The iAtlantic project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 818123. This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

