Into the blue

Professor Michael St John discusses the EURO-BASIN project, which aims to bring North Atlantic environmental institutes together, elucidate the inner workings of the Ocean's ecosystems and reveal how these are affected by climate change and increased human intervention

To begin, could you explain the core objectives of the EURO-BASIN project?

The multidisciplinary EURO-BASIN team's core objectives are resolving the impacts of climate and fisheries on the structure of North Atlantic marine ecosystems. Changes in ecosystem structure can lead to important consequences for the sequestration of greenhouse gases in the deep ocean, the production of fish stocks and ultimately feedback to global climate. The North Atlantic is one of the key areas influencing global climate and our understanding of its importance for climate is still in its infancy. The project's activities will contribute to this understanding.

What are the key challenges faced in understanding the dynamics of North Atlantic ecosystems and how does the EURO-BASIN project aim to respond to such challenges?

There are many challenges facing us but probably the biggest is the vastness of the region, the complexity of the interactions and, with the spatial limitations of existing sampling techniques, our ability to examine only a small area at any one time. Think of it as the story of the blind men and the elephant. As they touch different parts of the elephant these men come to different conclusions about the animal. Similarly, we are looking at a vast area through a keyhole and trying to understand how the whole system is functioning. Add to that the fact that the whole system is in motion, while the biological and biogeochemical components in it are evolving in space and time.

How do you intend to use modelling techniques to further our understanding of climate variability on marine ecosystems and the feedbacks to the Earth system?

Coupled climate-physical oceanographic, single species and ecosystem models serve as the glue for developing our understanding of how these ecosystems will evolve as well as helping us overcome our problem of scale. For example, models use relationships derived from experiments and observations on the effects of temperature and food availability on an organism's feeding and growth. The models allow us to extrapolate process mechanisms so we can better understand how our key species control the flow of carbon through an ecosystem and ultimately influence the storage of carbon in the deep ocean. They also allow us to simulate how ecosystems and their key species will fare under different future scenarios. Models serve as the state of our predictive art; without them, our understanding of the evolution of the system and its feedbacks to climate would be little more than a guess.

Can you highlight how the project aims to develop understanding and strategies that will improve and advance ocean management?

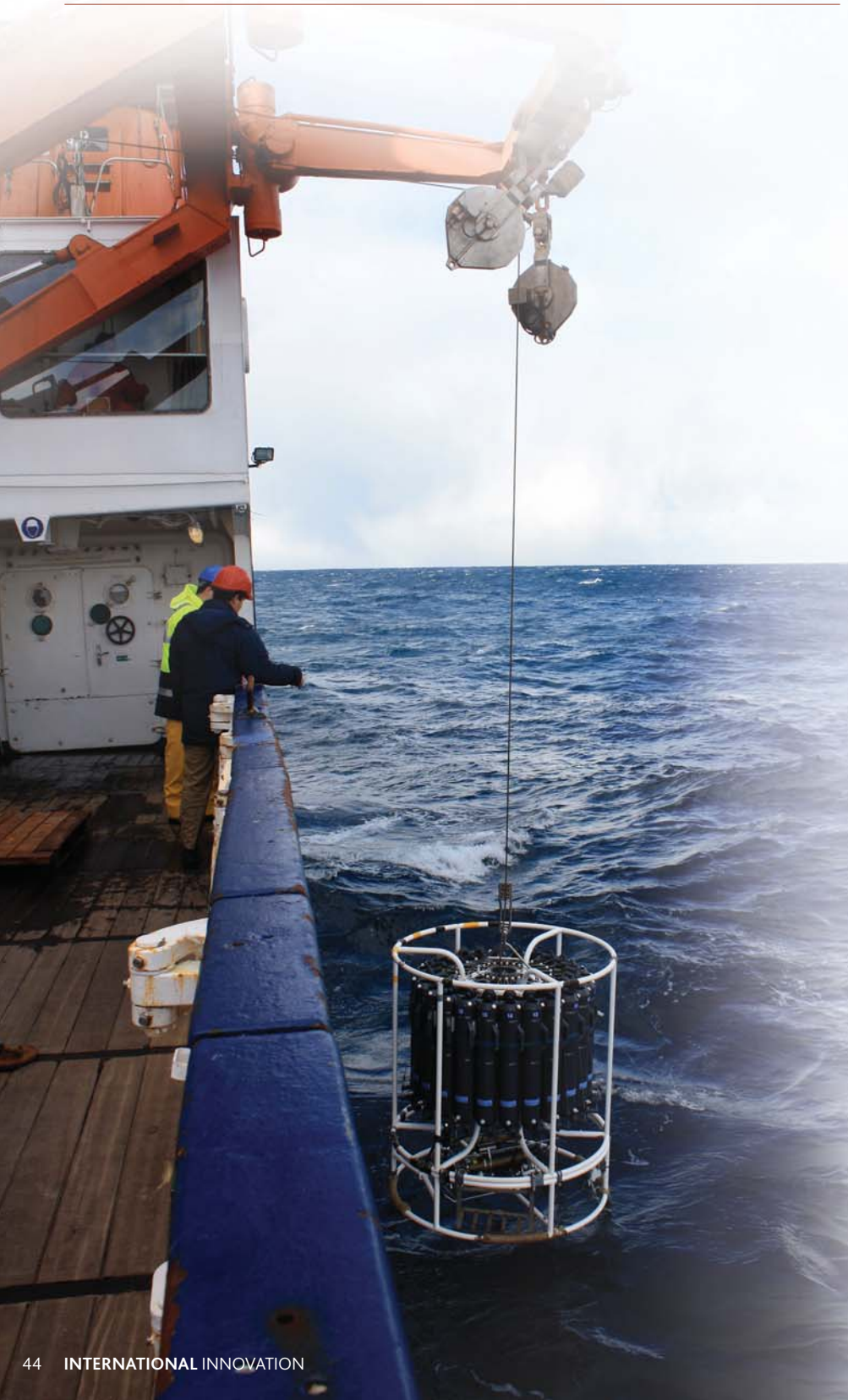
To manage our oceans we must understand how populations of key species, some of which we harvest, will change as their habitats evolve due to climate. Our laboratory and field activities define the habitats critical for their survival, while our coupled climate-physical oceanography-ecosystem models allow us to simulate the occurrence of these habitats and, as a result, the success of these species in the future. This information will empower managers to modify harvesting practices to preserve these key species and the services they provide. Furthermore, by identifying these key habitats, fish spawning grounds, for instance, we can provide environmentally-based advice for shipping and the placement of offshore energy facilities, as well as understanding the consequences of mineral extraction. Finally, our understanding of the effects of marine ecosystem structure on greenhouse gas storage is rather rudimentary. The project supplements and extends our knowledge in this area with the potential to better understand the role of marine ecosystems in climate regulation, thereby developing better management strategies to enhance the role of marine ecosystems in climate.

How is the EURO-BASIN project linked with other similar projects internationally?

EURO-BASIN was originally planned to form part of a transatlantic collaboration with the US and Canada. In fact, scientists from both sides of the Atlantic collaborated to develop an international science plan to help focus a joint programme. Unfortunately, funds were not forthcoming for the North Americans to link with the European initiative. At the moment, EURO-BASIN is the only major funded ecosystem-based project in the North Atlantic but this does not stop international collaboration. The research activities performed by EURO-BASIN allow North American scientists to link their activities to research cruises and project meetings, providing a skeleton upon which other smaller projects developed by North American scientists can fill research gaps in the EURO-BASIN programme.

A new approach to North Atlantic research

The North Atlantic Ocean holds key information on the effects of global climate change and human impacts on marine ecosystems, yet much is still to be learnt about its underlying mechanisms. **EURO-BASIN** is developing novel tools for unifying ecosystem research activities



ONCE CENTRAL TO the migration of Western settlers moving to the Americas, the North Atlantic Ocean continues to provide a home for a wealth of fish species and complex marine ecosystems. Integral to the societal and economic survival of its many surrounding nations in Europe and North America, a vast proportion of the Ocean's deep and shelf sea regions helps to support fisheries and sequester our planet's greenhouse gas emissions.

The North Atlantic ecosystems are a major player in the global carbon cycle, responsible for 5-18 per cent of the annual atmospheric carbon sequestered by the oceans. These ecosystems, the key species responsible for carbon flow, and their habitats, are constantly changing, under the influence of both large-scale fishing and climate change. Their evolving capacity to sequester carbon and provide services to society, should current climate and fishing trends continue, still warrants further investigation. However, the current gaps in knowledge have left environmental institutes unable to arrive at an agreed technique for marine system management.

Actively researching the connections between ecosystem dynamics and oceanographic processes, Professor Michael St John coordinated the launch of the project 'European Union Basin-scale Analysis, Synthesis and Integration' (EURO-BASIN). Initially set up to assess the potential impact of climate change and fisheries on the North Atlantic, EURO-BASIN aims to: uncover the major processes that influence the North Atlantic basin's various ecosystems; achieve better methods for forecasting changes in species distribution due to climate change; and successfully integrate positive strategies that will improve and advance management of the basin's ever-evolving ecosystems.

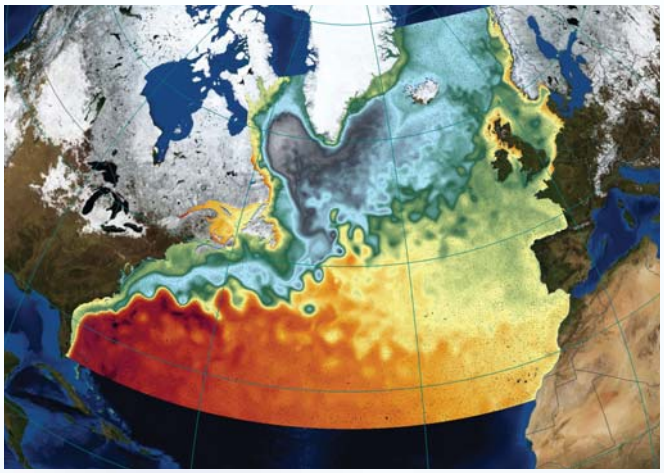
PAST AND PRESENT METHODS

Split across eight work packages of various disciplines, the project utilises existing data and current best practices while conducting its own laboratory investigations, field research and applying shared modelling techniques. These range from simple ecosystem models to fully coupled end-to-end (lower and higher trophic level) models.

EURO-BASIN is conducting several mesocosm experiments, which give researchers the advantage of being able to study minor sects of the natural environment under controlled conditions. Between mid-July and late August 2012, an experiment will be conducted at the Sletvik Field Station, Bay of Hopavågen. Run by the Norwegian University of Science and Technology (NTNU) and associated with the HYDRALAB IV network of European institutes for hydrological research, the station will host the investigation of 18 'core' mesocosms with different food webs to establish the variances in biomass production and flow of materials due to bacteria, phytoplankton and organisms involved in the basin's food structure.

In addition, major cruise campaigns are planned for 2012 and 2013. A series of localised cruises in 2012 is being conducted in parallel with the mesocosm experiments. A joint venture for 2013

between research vessels from Germany, Norway, Canada and the UK will survey the seasonal change in key species in the ecosystem and their natural habitats. Set to begin in March and end in August, the study will perform three sequential return transects of the North Atlantic, making it the first coordinated seasonal survey of its kind.



RESOLVING MORE AT A BASIN-SCALE. A HIGH-RESOLUTION MODEL OF OCEAN PHYSICS IN WHICH BETTER ECOSYSTEM KNOWLEDGE WILL BE EMBEDDED
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A COMMON GOAL

The researchers believe that a common approach to ocean management is long overdue, especially for the North Atlantic basin, which represents a key element to global climate change. St John enlisted the assistance of experts from institutes around the North Atlantic with the hope of bringing together a wide range of knowledge and resources. The participation of these countries holds particular significance as they are all historically responsible for the anthropogenic pressures exerted on the region.

EURO-BASIN is in its early stages, but has already made considerable leaps in progress. The 'Deep Convection' ocean expedition onboard the research vessel FS METEOR between the Faroe Islands, Iceland and Norway for instance, has discovered several key aspects regarding the processes involved in the local ecosystem during winter and early spring. The project is also engaging researchers from Canada and the US at a joint strategy meeting (6-8 November 2013 in Lisbon), which intends to develop a long-term regional research programme focused on the North Atlantic.

LEADING THE FIELD

Funded by the EC's DG Research under the Seventh Framework Programme (FP7), the project receives further support from its partner institutes, who offer contributions of equipment, vessel time and manpower. The institutes themselves also receive funding from their respective national governments, nearly tripling support for the research area as a whole.

Despite its success, the project has met numerous challenges, ranging from logistical issues linked to the North Atlantic basin's extent, to formulating the best approach to integrative knowledge management. With so many contributors scattered across Europe working toward the same goal, research data needs to be accessible and available. To ensure this, the project will archive all newly generated datasets at the World Data Centre for Marine Environmental Sciences (WDC-MARE) and later disseminate as peer-reviewed data publications in the open access journal *Earth System Science Data* (www.earth-system-science-data.net).

St John feels that the sharing of research data is essential if we ever wish to manage our environment effectively: "Research data is the currency of knowledge and our understanding of the environment". The project plans also include publication of recommendations for ocean management and the potential outcomes from continuing certain practices on North Atlantic ecosystems. In addition, EURO-BASIN will make all its research results and publications freely available to developing countries and the public at large via the OpenAIRE open access repository for research publications (www.openaire.eu).

SHARED ASPIRATIONS

The tools and connections established by EURO-BASIN will allow for more accurate means of surveying species and help to address major political objectives, including the European Common Fisheries Policy, part of which aims to achieve an ecosystem-based approach to the management of the North Atlantic basin, the Marine Strategy Framework Directive and the Maximum Sustainable Yield concept first agreed on by the World Summit on Sustainable Development.

Ecosystem interactions account for everything from fish production to carbon storage and cannot be predicted solely through classic reductionist scientific means. Following this, the EURO-BASIN team is now working on a hybrid modelling tool, which has the potential to alleviate any previous constraints and allow scientists to better predict how ecosystems and their species and processes might be changing, giving a clearer picture and stronger knowledge base. Besides providing the information necessary for current and future institutes to draw up strategies that will advance ocean management, predict the environmental effects of mineral extraction and offshore energy facilities, St John highlights that the tool could also be utilised in other, more diverse areas: "If the tool is successful in marine ecosystems, the most complex of these adaptive systems, it will prove useful for prediction in other systems such as economics and earthquake prediction, to name but a few".

EURO-BASIN

EUROPEAN BASIN-SCALE ANALYSIS, SYNTHESIS & INTEGRATION

OBJECTIVES

To advance understanding on the variability, potential impacts, and feedbacks of global change and anthropogenic forcing on the structure, function and dynamics of the North Atlantic and associated shelf sea ecosystems as well as the key species influencing carbon sequestering and ecosystem functioning.

PARTNERS

DTU-Aqua, **Technical University of Denmark**, Denmark • **Aarhus University**, Denmark • **Collecte Localisation Satellites**, France • **Centre National de la Recherche Scientifique**, France • **Institut français de recherche pour l'exploitation de la mer**, France • **Institut de Recherche pour le Développement**, France • **Université Pierre et Marie Curie**, France • **MARUM**, Germany • **University of Bremen**, Germany • **IHF**, **University of Hamburg**, Germany • **HAFRO**, Iceland • **Marine Research Institute**, Iceland • **University of Nordland**, Norway • **Institute of Marine Research**, Norway • **Uni Research**, Norway • **National Marine Fisheries Research Institute**, Poland • **Fundación AZTI**, Spain • **Instituto Español de Oceanografía**, Spain • **Institute of Marine Sciences**, Turkey • **Middle East Technical University**, Turkey • **CEFAS**, UK • **NERC National Oceanography Center**, UK • **Plymouth Marine Laboratory**, UK • **SAHFOS**, UK • **University of Swansea**, UK • **University of East Anglia**, UK • **University of Strathclyde**, UK

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PROFESSOR MICHAEL ST JOHN has served on the German Science Foundation's (DFG) Oceanography commission. He has been active in both the IGBP programmes IMBER and GLOBEC as the co-chair of the Ecosystems End-to-End group. His primary research focus has been that of coupling variations in species dynamics to physical oceanographic phenomena.