Cullen Scholarship: Modelling climate change impacts in Ireland's marine ecosystem using the Atlantis model (PhD Award)

Background

Climate change poses significant threats to marine ecosystems and our understanding of the impacts of climate change on these ecosystems needs to be enhanced to plan and adapt effectively for the future. Currently, ocean climate change monitoring and assessment is not mandated under EU policy or legislation. However, there are plans for climate change to be integrated into Marine Strategy Framework Directive (MSFD) reporting assessments. Additionally, there is a growing need to improve our understanding of climate vulnerable species and habitats to contribute to the Nature Restoration Law and national climate efforts, including the National Climate Change Risk Assessment.

Climate change is a cross-cutting horizontal issue and achieving a comprehensive understanding of ocean climate change requires consideration of many factors across a variety of disciplines. End-to-end marine ecosystem models represent the entire ecological system, incorporating all features of the marine environment, including the physical environment, biogeochemical processes, food-web dynamics and human activities. These models allow us to explore how changes in the marine environment, both physical and biogeochemical, affect marine species and habitats and the ecosystem services they provide. Atlantis (Audzijonyte et al., 2019) is a widely used 3D ecosystem model used for large scale strategic questions to explore potential marine ecosystem change under different scenarios, including climate scenarios. Atlantis enables us to assess how marine environmental changes will unfold across the entire marine system, right through to ecosystem services and socio-economics, at various spatial and temporal scales. The model is best used to explore large scale strategic questions such as 'what-if' scenarios rather than tactical management decisions, such as fish stock assessments.

We propose the development of an Atlantis model for Ireland's marine ecosystem to evaluate when environmental conditions may not be suitable for some species under future climate scenarios. This model could be used to assess climate impacts of Good Environmental Status under the Marine Strategy Framework Directive. These predictions could also inform other EU and national policy including the Nature Restoration Law, the designation of Marine Protected Areas, Climate Adaptation Plans and the National Climate Change Risk Assessment.

Proposal

We propose **a structured four-year PhD** on a full-time basis to develop an end-to-end ecosystem model to explore the impacts of climate change on Ireland's marine ecosystem.

The project will aim to:

- Conduct a comprehensive literature review to understand how various functional groups respond to a range of climate drivers and identify species and habitats most at risk of climate change in Ireland's Exclusive Economic Zone.
- Identify, gather and process relevant data needed as model inputs, including data on physical and biogeochemical processes, functional group traits, species biomass, food web structure and human pressures such as fishing.
- Build, configure and calibrate an end-to-end ecosystem model for Ireland's marine ecosystem to ensure model outputs provide realistic ecological predictions.
- Implement the model to evaluate the impacts of climate change on Ireland's marine ecosystem under various climate scenarios.

Location of Scholar and Training Provided at the Marine Institute

The scholar will be based for circa 50% of their time over the four years at the Marine Institute HQ Rinville, Galway.

Outcome

The proposed project will significantly enhance our understanding of the impacts of climate change on Ireland's marine ecosystem. It is expected that the project will identify species and habitats most at risk to climate change, which could be used for climate vulnerability mapping.

The Atlantis model developed will allow us to evaluate how different climate scenarios will affect the marine ecosystem. It is anticipated that model outputs will be used to integrate climate change into MSFD reporting, assessing the effects of climate change on the good environmental status of our waters. Additionally, model outputs could contribute to the designation of Marine Protected Areas and inform work under the Nature Restoration Law, ensuring that conservation efforts are appropriate under future climate scenarios. The model will also be valuable for future climate adaptation plans and climate risk assessments, including the National Climate Change Risk Assessment.

Marine Institute Corporate Strategy 2023-2027

The table below summarises which strategic priority areas of the Marine Institute's corporate strategy Ocean Knowledge that Informs and Inspires (headings in table,) and the associated strategic initiatives (numbers in table) that this project will address.

Advice and services	Climate and biodiversity	Research and innovation	Digital Ocean	Blue Economy	Sustainability	Stakeholders and society
1,3,4,6,8	1,2,3,4,5,6	1,3,5	1,2,3,4	2,3	2	2,5

Specific Requirements

The scholar should have a primary degree in marine science, physical oceanography, physics, ocean sciences, mathematics, IT, computer science or engineering.

Financial Details

Scholarships will be up to €34,000 per annum (maximum funding PhD of €136,000 over four years). This amount comprises a maintenance award of €25,000 to the student as well as payment of fees to the host higher education institution (HEI). The maximum fees payable to the HEI will be €6,000 per annum. The scholarship award also includes a budget of up to €3,000 per annum for eligible research costs (travel & subsistence, publication costs, consumables and other costs, such as minor kit purchase e.g. camera) for the sole use of the student, and are payable on a reimbursement basis direct to the host institution where the postgraduate student (scholar) is registered. There are no overheads payable on the scholarship.

Publication costs are intended to cover publications on which the scholar is listed as first author and are published under Open Access.

Scholars can also supplement this funding by applying to the Marine Institute's Networking & Marine Research Communication Awards annual call.

In addition, the cost of a laptop will be covered by the Marine Institute (purchased via the Research Funding Office).

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References

- Audzijonyte, A., Pethybridge, H., Porobic, J., Gorton, R., Kaplan, I., & Fulton, E. A. (2019). ATLANTIS: A spatially explicit end-to-end marine ecosystem model with dynamically integrated physics, ecology and socio-economic modules. *Methods in Ecology and Evolution*, *10*(10), 1814–1819. https://doi.org/10.1111/2041-210X.13272