Foras na Mara
Marine Institute

Post-Doctoral Fellowship: Proposal Outline

Topic	Understanding mussel (*Mytilus edulis*) responses to changing ocean conditions in Irish waters
Research Theme(s)	Climate Change: Understanding key climate trends in the oceanic and atmospheric domains. Sustainable food from the sea: understanding a key commercial shellfish species response to changing ocean conditions. This research aligns with gaps identified in Ireland's National Strategic Plan for Sustainable Aquaculture Development.
Background and Rationale (including Strategic Priority)	Global consumption of fisheries and aquaculture products has doubled since the 1960s. Low-impact regenerative aquaculture has the potential to produce six times the amount of protein currently produced if managed and scaled effectively. In Ireland, Fisheries, aquaculture and seafood processing produced a combined Gross Value Added (GVA) of €360m in 2022, of which mussels are a key production species, grown both on the seabed and suspended mussel lines around the Irish coast. Existing data sets in Ireland and Europe show that mussel recruitment and condition have declined. This may be due to physiological stress and reduced scope for growth brought about by changes in environmental conditions, pollution, disease and carrying capacity but the causes are as yet unknown. In recent years, there has been limited spatfall in subtidal habitats in the Irish Sea for instance which is the main source of seed for the bottom mussel aquaculture industry and growth rate has declined in rope mussel culture off the south west coast. The aquaculture industry is concerned about the future viability of both the bottom and rope mussel industries. The implication of changes in environmental conditions on mussel productivity can be modelled using dynamic energy budget (DEB) approaches if the physiological responses of mussel to these various environmental conditions can be evaluated. DEB output can then be used to predict future suitable habitat for mussel based on modelled marine forecasts for Irish waters. As an island on the western boundary of Europe facing the Atlantic Ocean, Ireland is ideally positioned to measure and assess changing ocean conditions and to use key oceanographic, biological and habitat data sets to provide context for changes to ocean ecosystems including the condition and distribution of mussels.

	Assessing changes in mussel productivity requires multi-disciplinary research using a combination of field, laboratory and model experiments that are the scope of this fellowship. By utilizing key national laboratory infrastructure, dedicated aquaculture research sites in the sea and complex hydrodynamic and ecophysiological (DEB) modelling, this project aims to identify the major environmental factors impacting mussels and to combine marine forecast modelling and DEB to predict future distribution of suitable habitat and productivity of mussels. The modelling approach is transferable to other commercially important aquaculture species such as oysters and wild populations of molluscan shellfish. The project objectives are relevant to several Marine Institute strategic priority areas (e.g. advice and services, climate and biodiversity, environmental monitoring, research and innovation, Blue Economy, stakeholders and society). The proposed research will support objectives and actions in Ocean Knowledge 2030 addressing "Sustainable food from the ocean" and to "Tourism in coastal and marine areas". Mussel beds are a component of Group 3 habitats listed in the Nature Restoration Regulation and which will be included in Irelands nature restoration plan in 2026. The objective is to restore these habitats to good condition. This project will enable the feasibility of this objective to be tested.
Scope of Research (Scientific/ Technical Challenge)	**This research project aims to** assess the key ocean variables that impact on the life cycle and productivity of mussels in Irish waters and to model the effect of changes in key ocean variables on future distribution and habitat suitability for mussels. In-situ oceanographic data, ocean circulation and ecosystem models and satellite imagery will be used to describe and forecast changes in environmental variables. The physiological response of mussel to these key variables will be measured experimentally. Both will be combined, using DEB, to predict future distribution, productivity and habitat suitability for mussels. This will lead to improved knowledge for policy makers and the Irish aquaculture industry in terms of current and possible future prospects for mussels and other shellfish species in Irish waters. **The overarching aim of this fellowship is to** better understand the key environmental drivers of mussel reproduction, settlement, recruitment and growth, to inform industry on future strategies to maximise the potential of the mussel industry and wild populations in Ireland. **The fellowship will address the following key research objectives:** - Identify the current distribution of mussel in Ireland both sub-tidally from historic and recent survey data and intertidally from walkover surveys of key sites in Ireland where there is already a time series of sampling (for Water Framework Directive). Aerial imagery from UAV can be used to identify distribution of mussel in intertidal habitats. This has been done in MI under various recent projects.

	- Conduct laboratory eco-physiological experiments in a controlled test environment where multiple environmental variables can be modified and the effects on mussel growth and condition can be described. - Investigate the potential of archived samples such as isotopes, hybridisation and metabarcoding techniques. - Develop DEB models using new data from the eco-physiological experiments and oceanographic model output. to establish a predictive capacity for mussel spatfall, likely reproductive success and preferred mussel habitats. - Produce various targeted communications to include infographics, policy briefs and peer-reviewed publications outlining the key findings from this research. The fellow will collaborate closely with the Marine Institute's (MI) OCIS, MEFSS and FEAS service groups in this multi-disciplinary research. DEB modelling and ocean modelling expertise exists in OCIS.
Expected Impact(s)	- Understand the key environmental variables that contribute to mussel life cycles and reproductive success. - Results from a suite of laboratory (and/or use of archived samples), experiments that improve scientific understanding of mussel responses to changes in environmental variables. - Improve the evidence base for management of mussel fisheries In Ireland. - Strengthen interdisciplinary research between oceanography, marine chemistry and fisheries science. - Produce integrated policy briefs for stakeholders, and publish research findings as widely as possible through peer-reviewed papers, conference presentations, articles, etc.
Outcomes	- Report outlining key environmental variables that impact mussel growth and condition - Produce short-term and longer-term forecast for mussel habitat suitability in relation to growth and condition to aid the aquaculture and fishing industry. - Targeted communication materials for industry, policy makers, the public and scientists e.g. summary for policymakers, industry leaflets and workshops, infographics, dashboards, scientific publications. - Please contact the Marine Institute scientists listed below for a list of suggested milestones, and associated timelines, for the project.
Specific Collaboration	This fellowship is a Marine Institute funded activity and will link to Bord Iascaigh Mhara (BIM) activity in the SW and East Coasts of Ireland.

Location of Fellow	Primarily based in the Marine Institute with research visits to major aquaculture production areas and experimental facilities as required. The fellow will be based at the Marine Institute, Rinville, Oranmore Galway. **Contacts:** Glenn Nolan, Oliver Tully, Brendan Mc Hugh, Marine Institute. Nicolas Chopin, Bord Iascaigh Mhara.
Duration and Funding Available	4 years €100,000 per annum (i.e. total €400,000 maximum for duration of four years) This fellowship is funded by the Marine Institute
References	Chopin N. (2024) Temporal and Spatial Settlement of Subtidal Seed Mussels on the Southeast coast of Ireland, M. Phil Thesis, Bangor University Morris et al. (submitted) Role of sea surface temperature on the shell and tissue growth on suspended blue mussels (Mytilus Sp) in Irish waters from 1992-2022 Giltrap et al (2013) Assessment of biomarkers in *Mytilus edulis* to determine good environmental status for implementation of MSFD in Ireland. Marine Pollution Bulletin, 71, 240-249.