Cullen Scholarship: Investigating food web dynamics and response to environmental change in a deep humic lake (PhD Award)

Background

Lough Feeagh is a deep, humic freshwater lake located in County Mayo, Ireland, within the Burrishoole catchment. Due to its low nutrient levels, Lough Feeagh supports a characteristic oligotrophic ecosystem, with brown waters, limited primary productivity, and a conservationally important fish community, including Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*) and European eel (*Anguilla anguilla*). The lake ecosystem has been impacted by land use change (Dalton et al. 2014), climate change (Dokulil et al. 2021; O'Reilly et al. 2015; Woolway et al. 2019) and declining fish stocks (Cotter et al. 2022; de Eyto et al. 2016; Poole et al. 2018; Vaughan et al. 2021; Woolway et al. 2019). Modelling of future climate impacts indicate changes in evapotranspiration (Ayala et al. 2023a), growing season (Ayala et al. 2023b) and salmonid growth rates (Rinaldo et al. 2024) are to be expected. A comprehensive understanding of the dynamics of the lake ecosystem will aid in the protection and management of the system. This project will also build on the Atlantic Salmon Trust funded salmon food web study undertaken in the catchment (de Eyto et al. 2020) and similar to the EFAF funded food web study of the tidal lagoon, L. Furnace (Graham et al. in prep.).

Ecopath with Ecosim (EwE) is an ecosystem modelling software used to analyse the flow of energy and biomass in aquatic ecosystems (Christensen and Pauly 1993). It helps understand how different functional groups interact within a food web by quantifying their trophic relationships. Ecosim is a time-dynamic simulation module within EwE. It allows changes in the ecosystem over time to be simulated considering factors like environmental shifts (such as those caused by climate change) and land use shifts (such as those suggested in the Wild Nephin restoration plan), species interactions and management changes.

The high resolution data on Lough Feeagh available from the long-term catchment and fisheries monitoring in the Burrishoole catchment will allow for the implementation of comprehensive scenario testing. Example scenarios could include:

1. Effect of rising water temperatures.
2. Land use changes (agriculture/forestry) effect carbon inputs to the lake.
3. Declines in salmonids/eels on the overall functioning of the ecosystem.
4. Shifts in the phytoplankton/zooplankton community and the knock on effects on the higher trophic levels.

Overall, a food web model will facilitate our understanding of this critically important habitat.

Proposal

We propose **a structured four-year PhD** on a full-time basis to investigate the food web dynamics of Lough Feeagh, Furnace, Co. Mayo.

The project will aim to:

- Develop an EwE model of Lough Feeagh using data collected by the Marine Institute in Newport.
- Investigate the tropic dynamics of the lake food web model.
- Utilise the food web model to investigate the effects of environmental change on the lake (e.g. climate induced temperature shifts, land use changes in the catchment from forestry).

Location of Scholar and Training Provided at the Marine Institute

The scholar will be based over the four years at the Marine Institute in Newport (Furnace). The scholar will be trained in sampling and analysis techniques of freshwater habitats and statistical modelling using Ecopath and R.

Outcome

The expected outcomes from the project will be an EwE model of Lough Feeagh investigating the food web dynamics of the system along with some scenarios of the effect of environmental change in the system.

Marine Institute Corporate Strategy 2023-2027

An EwE model of Lough Feeagh would provide a scientific foundation for multiple elements of the Marine Institute's strategic objectives, particularly in marine and freshwater research, innovation, policy, and conservation. Under strategic priority 2 "Meeting Climate, Biodiversity and Seafood Security Challenges" initiative number 7 of the Marine Institute's corporate strategy Ocean Knowledge that Informs and Inspires, this research to develop a food web model of Lough Feeagh would help identify critical freshwater influences on migratory fish species like Atlantic salmon and European eel. The Burrishoole catchment is recognised as an international index site for diadromous fish. Information on the fish populations feeds into national management plans for salmon and eels. By applying Ecopath, Ecosim, and Ecospace, the model can provide dynamic, predictive scenarios for assessing the impact of climate change and ecosystem restoration on lake ecosystems, which can help develop sustainable management strategies for the fish populations within the lake.

Specific Requirements

The scholar should have a background in ecology, environmental science, marine/freshwater biology or similar. A strong mathematical ability will be an advantage.

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