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Importance of Physico-chemical Cycling of Nutrients and Carbon in Marine Transitional Zones (Nuts & Bolts)

Authors: Peter Croot, Rachel Cave, Sheena Fennell, Maija Heller, Tiernan Henry, Nadeeka Rathnayake, Fatimatuj Zohara Sonny and Dagmar Stengel

Lead organisation: University of Galway

What did this research aim to address?

The Nuts & Bolts project examined the physical and chemical controls on the biogeochemistry and bio-optics at four sites representing different exemplars of Irish marine transitional zones (MTZs): (i) the Shannon estuary; (ii) Kinvara Bay – a site influenced by submarine groundwater discharge; (iii) Lough Furnace – a meromictic lagoon; and (iv) the outflow plume of the River Corrib in Galway Bay.

For the purpose of determining good environmental status (GES) in the context of the Marine Strategy and Water Framework Directives, Nuts & Bolts was designed to address knowledge gaps regarding the action of multiple environmental stressors on Irish MTZs. The approach included (i) application of flow cytometry to study pico- and nanoplankton distribution, abundance, growth and mortality rates; (ii) inclusion of coloured dissolved organic matter and fluorescent dissolved organic matter as tracers of carbon cycling; (iii) measurement of in situ bio-optical properties along salinity gradients to assess light quality and impact on primary production; and (iv) application of membrane inlet mass spectrometry to determine climate-relevant dissolved gases (O2, CO2, Ar and dimethyl sulfide). Data from Nuts & Bolts provide essential baseline information for evidence-based decision-making on key environmental aspects of Irish MTZs related to management and governance.

What did this research find?

Nuts & Bolts generated new datasets on the abundance and distribution of bacteria and pico- and nanoplankton, along with information on their growth rates, grazing rates and how they may respond to changes in light, nutrients and temperature. This information fills a critical gap from a management and governance perspective in Ireland, and allows for picoplankton in MTZ ecosystems to be given more attention in planning for GES and the Marine Strategy Framework Directive, including their impact on the descriptors for biodiversity, non-indigenous species and food webs and on eutrophication and harmful algal blooms.

New biogeochemical data on the environmental stressors impacting Irish MTZs, including nutrient and metal fluxes, in situ light field and potential greenhouse gas fluxes, were also obtained. Viewing the MTZ as a whole ecosystem, as is done now in river management by examining the whole catchment, allows for a more complete picture of the bio-optical and biogeochemical processes occurring in MTZs. This work thus helps to inform management decisions in each of the MTZs and creates a framework for future studies in other important Irish MTZs.

How can the research findings be used?

The new data allow us to improve the ability to predict the impact of climate change and other anthropogenic stressors (e.g. eutrophication, coastal darkening) on GES in MTZs by including biogeochemistry and bio-optics in the modelling of Irish MTZs. This should be done as part of the National Marine Monitoring Programme, co-ordinated by the EPA. An approach to this would be to start with the LOICZ box model methodology for each of the Irish MTZs. For MTZs with existing hydrodynamic models (e.g. Galway Bay, Shannon estuary), implementation of the PISCES biogeochemical model would greatly improve the ability to forecast future ecosystem changes. Critical to this is improving assessment of the nitrogen balance in MTZs by examining all relevant nitrogen species and the fluxes between them, including benthic source and sinks. It is also strongly recommended that existing harmful algal bloom surveys include a flow cytometric analysis of bacteria and pico- and nanoplankton abundances. The findings of Nuts & Bolts should be followed up and broadened to include other MTZs, most notably those in the south and east of Ireland, which are more heavily impacted by agricultural run-off.

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