Factors controlling microbial nitrogen cycling and nitrogen pollution from farm to coast

Supervisory team:
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Host institutions: Rothamsted Research (North Wyke), Plymouth Marine Laboratory

Submit applications for this project to Rothamsted Research

Project description:

Sustainable land-use and agricultural practises aim to reduce the introduction of excess nitrogen to soils and waterways whilst maintaining productivity to feed the increasing world population. However, transport of nitrogenous material from land continues to be problematic due to high levels of leached nitrate and emissions of the greenhouse gas nitrous oxide.

Elevated nitrate can prove problematic in abstracted drinking water, can result in eutrophic conditions and environmental degradation which affect fisheries, bathing waters and the usability of beaches, and may dramatically impact on the biodiversity within river, estuary and marine ecosystems. It is essential that inputs of nitrate from agricultural, wastewater and sewage treatment to water catchments and thus estuarine and coastal waters are managed effectively, and as such are included in the Nitrates, Water Framework and Marine Strategy Framework directives. Nitrous oxide is considered the third most important of the greenhouse gases. Emissions from humankind's activities and through release from natural systems are accountable through the UK's signature of the Kyoto protocol and, under the conditions of the 2015 Paris Agreement, the UK is obliged to contribute to a reduction in greenhouse gases.

The biogeochemical cycling of nitrate is controlled by the actions of soil, sediment and water dwelling microbes. The most important pathway for nitrate removal (to nitrogen gas) is anaerobic denitrification but under the presence of small quantities of oxygen, nitrous oxide is produced. The process of nitrification converts ammonia to nitrate under oxygenated conditions also generating nitrous oxide. This project will provide detailed knowledge of key sources of nitrate entering the Tamar catchment, and the influence of environmental factors (e.g. local land use, season, extreme weather) on the removal of nitrate and production of nitrous oxide by nitrogen cycling microbes. A combination of molecular biology techniques (DNA extraction, quantitative PCR, sequencing) will be used to determine the abundance of denitrifying and nitrifying microbes along the Tamar, and this data compared to nitrate and nitrous oxide concentrations and nitrification and denitrification rate measurement to understand the key players and processes involved in both nitrate removal and nitrous oxide generation. Alongside the field data generation, an ecosystem model of oxygen-sensitive nitrogen cycling processes will also be used to further test the influence of environmental factors or stressors on nitrogen removal processes.

Ultimately, this project will develop a tool kit to inform on sensitivities on the nitrogen cycle to anthropogenic and environmental pressures from farm to coast