Student Research Projects

NIOZ Marine Masters Summer Course 'Exploring the Wadden Sea'
NIOZ Royal Netherlands Institute for Sea Research, Texel
6 - 18 July 2025

Project 1: Tidal dynamics of the Marsdiep

The Wadden Sea is a complex tidal ecosystem, changing continuously in terms of currents, waves, sea level, temperature, salinity, sediment concentration and hence light conditions and availability of nutrients. This dynamic environment drives the biodiversity and productivity of the lower parts of the food chain (phytoplankton and zooplankton). In this project you will use temperature and salinity observations, as well as recorded velocities, over the entire depth of the field site to characterize the water flowing through the Marsdiep during one complete tidal cycle. Analysis will reveal whether there are differences in water masses and whether there is net in- or outflow through the inlet. Biotic and abiotic consequences of the observed hydrodynamic conditions can then be derived. For this project, programming experience is required (preferably Matlab or Python).

Project 2: Tidal dynamics and their effect on sediment transport

Every day, tidal currents move tons of suspended sediment from the North Sea into the Wadden Sea and back again, through the tidal inlets that breach the Wadden Sea island chain. In the Wadden Sea, sheltered by the barrier islands against the force of incoming waves from the North Sea, sediment particles suspended in the seawater settle out on the seabed. With time, sediments accumulate into vast tidal flats emerging during low tide, which are the typical landscape element of the Wadden Sea and an important habitat for marine life. Whether this landscape will remain during future sea level rise and local seabed subsidence depends on the balance of sediment import and export through the tidal inlets. In this project, you will quantify suspended sediment transport in the Texelstroom in relation to the dynamics of the tide.

Project 3: Using stable isotopes to unravel the Wadden Sea food web

The Wadden Sea is the major feeding ground for migratory birds resting in Northwestern Europe, but it also plays an important role for other species like seals, fish and invertebrates, to name a few. In this project you will use carbon and nitrogen isotope signatures of various Wadden Sea species, reflecting their past diet, to establish the predominant food sources and therewith a basic food web of the Wadden Sea. You will collect samples of phytoplankton and zooplankton in the water column, benthic algae, macro- and megafauna from the tidal flats (mudflat) as well as from sediment from greater water depths (Marsdiep). You will analyse these samples for stable carbon and nitrogen isotopes to investigate differences in the food web composition of both areas. The stable isotope data can be processed using R packages specifically designed for stable isotope

ecology. Are there differences in primary producers, potentially different baseline isotope values, and how does this move up the food chain?

Project 4: Tidal inlets – gateways for coastal zone methane export to the open sea

Methane is a potent greenhouse gas with a global warming potential that is 32 times higher than carbon dioxide. Since industrialization, atmospheric methane concentrations have risen from ~700 ppb to over 1900 ppb in 2021. While anthropogenic methane emissions are relatively well constrained, natural sources remain highly uncertain, particularly in marine environments where methane production, consumption, and transport processes are not well constrained. The inner shelf is the primary source of marine methane emissions to the atmosphere though it only comprises ~3% of the global ocean surface. In these shallow waters, high primary production leads to an accumulation of organic matter in sediments. As a result, organic matter degradation under anoxic conditions leads to high concentrations of dissolved and free methane in sediments. Transport of methane-rich porewaters as well as methane ebullition (bubble release) to the overlying water column lead then to elevated methane concentrations in the water column, where it may be consumed by microbes, liberated to the atmosphere or translocated by currents. In tidal systems such as the Wadden Sea, large volumes of water are exchanged with the open North Sea twice daily. Consequently, a substantial amount of methane released from Wadden Sea sediments is transported into the North Sea via tidal channels and inlets. In this project, you will collect water samples at discrete hydrocast stations and collect velocity data along a transect crossing the Marsdiep, and measure the methane concentrations in these samples using gas chromatography. Combining these measurements with methane distribution data will allow us to estimate the mass flux of methane leaving the Wadden Sea through the Marsdiep. Additionally, you will collect water and sediment samples to measure rates of methanogenesis and methanotrophy to further deepen our understanding of methane dynamics in this constantly changing marine system.

Project 5: Hunting for an uncultivated group of oxalotrophic bacteria in waters and sediments of the Wadden Sea

Oxalotrophy refers to a nutritional strategy by which an organism derives its cellular carbon and conserve energy from the degradation of oxalic acid and oxalate salts such as calcium oxalates. Among all oxalotrophic microorganisms (i.e., oxalotrophs), those inhabiting the gut of mammals are the most researched considering they limit the risk of kidney stones and regulate the absorption of minerals that are powerfully bound by the oxalate anion. In soils, oxalotrophs are known to have roles in e.g., plant nutrition and plant-microbe interactions. In contrast, nothing is known about the identity and function of marine oxalotrophs. Using metagenomics and comparative genome analyses, our team has recently unveiled the existence of an uncultivated group of oxalotrophic bacteria, the members of which are widely distributed in marine habitats. While several groups of algae, sponges and fungi are potential producers of oxalates in open ocean environments, halophyte plants are major sources in some coastal ecosystems. Furthermore, rivers can discharge oxalates of terrestrial origins in coastal ecosystems, while iron oxalates that are predicted to be abundantly formed in some airborne dusts may be deposited at the surface of open ocean waters. Altogether these observations suggest a myriad of potential functions for marine oxalotrophic bacteria. In this project, you will attempt to isolate marine oxalotrophic bacteria from water and sediments you will collect within a saltmarsh, which is a first major step in the study of the ecological function of these microorganisms. You will use several new microbiological media and a dilution-plating approach to grow microbial colonies, monitor the development of microbial (micro)colonies using

stereomicroscopy and validate that cells from pure colonies are capable of growing with oxalate as sole source of carbon by performing growth tests in liquid media.

Project 6: Links between seafloor characteristics and community composition of macrozoobenthic invertebrates

Macrozoobenthic organisms ensure important ecological functions in the Wadden Sea by regulating nutrient cycles and serving as key food sources for birds, fish and humans. As the Wadden Sea is composed of a dynamic mosaic of underwater landscapes (sand, mud, mussel patches, etc.), understanding how ecological communities of macrozoobenthic invertebrates vary along the sea floor is key to predict how future changes in the marine environment will affect these communities and the services they ensure. In this project, you will use a multibeam echosounder to map the seafloor and determine its physical characteristics. Then, using box corers, you will sample soft sediments at multiple sites characterized by contrasting environmental conditions. In the lab, you will then identify the macro-invertebrates present in each sample, before investigating which environmental variables influence the composition of macrozoobenthic communities using quantitative community ecology tools.