Characterizing and quantifying activity patterns of fish with accelerometer archival tags

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Micro-accelerometer tags are a novel technology used to remotely monitor (aquatic) animals in the wild and provide data that can link physiological and ecological processes in the context of movement. This new technology is particularity important for understanding activity patterns of fish, which can be difficult observe directly. This talk will provide an introduction on accelerometer sensors and the types of data that can be collected. We illustrate these points with data from accelerometer archival tags deployed on fish species at liberty in southeastern Alaska (Pacific Halibut) and in the Firth of Lorne Marine Protected Area, Scotland (Common Skate). Ultimately, we demonstrate how such data can be relevant for advancing the management of commercially valued species (Halibut) as well as endangered fish (Common Skate).

How corals apply the Goldilocks Principle to habitat engineering

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The occurrence and proliferation of reef-forming cold-water corals is reliant upon optimal current conditions, where provision of organic material is at a velocity suitable for prey capture by the coral. The occurrence of a significant proportion of dead skeletal framework on reefs highlights that when flow is sub-optimal, prey capture and ingestion rates are likely inadequate to facilitate survival. The reef forming coral *Lophelia pertusa* has an optimal range of flow velocities in which they can capture food efficiently. This 'Goldilocks Zone', where the flow is neither too fast nor too slow, will promote coral growth compared to zones of sub-optimal flow velocity. The disruption of flow by the coral also creates sub-optimal velocity regions behind it, potentially contributing to mortality of downstream corals. Here we demonstrate using Particle Imaging Velocimetry how corals modify their flow environment, and how cold-water reefs grow according to the Goldilocks Principle, by using a theoretical laminar flow system and iterative growth of a model coral.

Phytoplankton: helping support the environment and society.

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Phytoplankton provide important climate cycle and ecosystem functions, and must be incorporated within marine management considerations. Phytoplankton are currently considered within environmental standards, but often negatively - as indicators of unwanted environmental change, such as eutrophication or harmful algal blooms, with limited effort to consider or support areas of naturally higher productivity. In order for this to change, primary production must be fully recognized as vital ecosystem process, and phytoplankton as supporting other ecosystem services (ES) we value.

The spatially heterogeneous nature of phytoplankton parameter distributions must also be recognized, as spatial and temporal patchiness in the production of phytoplankton can be related to patchiness in the provision of these ES. This will require consideration of the physical environment creating the conditions (physical “habitat”) for the phytoplankton, as it is this which determines, for example, patches of high productivity and therefore importance to supported ES. Additionally, the effects of climate change induced shifts to baselines must be kept in mind.

Spatial and temporal phytoplankton variability off the east coast of Scotland, with its impacts on monitoring for MSFD and in marine spatial planning and sectoral licensing will be explored as examples. For example, mapping patches and considering effects of wind farms provides evidence of the impacts human developments can have on patches, and comparing remotely sensed to long term monitoring site data offers implications to methods of monitoring pelagic habitat status.

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Land Ocean Carbon TransfEr: Locate

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LOCATE is an ambitious and challenging new collaboration between the National Oceanography Centre (NOC; project lead), the Centre for Ecology and Hydrology (CEH), the British Geological Survey (BGS) and the Plymouth Marine Laboratory (PML). The project offers shared facilities and opportunities for collaboration, with activities in Scotland being coordinated by CEH. The NERC National Capability funded project aims to i) quantify the transport of carbon from soils, via river flow, to the ocean, at the GB scale ii) understand the key transformation and removal processes controlling terrigenous organic carbon (tOC) fluxes through the river, estuary and sea shelf, and iii) integrate this knowledge into models to predict how land-ocean fluxes of terrigenous organic carbon are likely to evolve under future climate and land-use scenarios.

Terrestrial ecosystems contain 1500-2400 Gt (Gt = 1012 kg) of C approximately twice as much as stored in the ocean and at least four times as much as the fossil fuel reserves combusted to date (Ciais et al., 2013). Every year an estimated 2 Gt is exported from this store to rivers; a flux comparable in size to the oceanic uptake of anthropogenically remobilised C. Approximately half of this material is lost (mainly to the atmosphere) in freshwater systems with ~50% of the remainder (0.5 Gt C y^{-1}) entering saline waters in organic forms (Cole et al., 2007). The extent of tOC removal along the land-ocean continuum reflect its lability, stoichiometry, and molecular structure, and the effects of respiration and degassing, photolytic breakdown, and sedimentation (e.g. flocculation in lakes and estuaries) (Bianchi, 2011; Cai, 2011).

Riverine (DOC) concentrations have increased over the past 25 years in large areas of North America and northern Europe due to changes in atmospheric deposition chemistry, climate, and land use (Monteith et al., 2007). These and other drivers will continue to change in the future, further affecting the quantity and composition of tOC exported to freshwaters (Monteith et al., 2007). However, we cannot currently predict how this will affect tOC exported to the ocean because of major uncertainties in the relative sizes of removal processes, the controls over them and their sensitivities to future environmental change.

LOCATE will run for five years, from April 2016, and will work to improve our understanding of tOC transport and processing at GB to global scales. We will introduce this programme of work, with a specific focus on the research planned within Scotland. We will demonstrate opportunities for collaboration across the project including access to shared laboratory and field facilities. As part of the planned work, a national survey of rivers and major estuaries will be conducted. In addition, three focus catchments will be studied in detail. In Scotland, the focus catchment is the Halladale and a field and experimental campaign is being planned for this site (2017-2019) in collaboration with the Environmental Research Institute, North Highland College, University of the Highlands and Islands.

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Bacteria, not macrofauna, are key players in the short-term degradation of phytodetritus in abyssal CCZ sediments

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The abyssal zone (3000-6000m) is truly vast, covering 54% of the Earth´s surface. The vast majority of the abyssal seafloor relies on exported labile components of phytodetritus from the euphotic zone for food. Whilst numerous studies have explored the importance of phytodetritus to deep-sea organism diets through gut pigment, fatty-acid and stable isotope analyses, it is only with the development of stable isotope pulse-chase techniques that researchers have been able to identify the initial responders to phytodetritus deposition events, and quantify rates of phytodetrital carbon and nitrogen uptake by the benthic community. In the only study so far carried out at abyssal depths that assessed the response of bacteria and macrofauna to phytodetritus, Witte et al. (2003) found that macrofauna were the dominant group involved in the initial degradation of phytodetritus at the eutrophic Porcupine Abyssal Plain (PAP). Here, we report on results from 10 in-situ benthic isotope tracer experiments carried out under mesotrophic abyssal settings. We show that bacteria, not macrofauna, are responsible for most C-turnover in sediments in the manganese nodule province of the Clarion Clipperton Zone (CCZ). We also show that these observations are consistent over regional scales. We noted no significant shift in bacterial diversity when sediments exposed to fresh phytodetritus, suggesting that shifts in bacterial diversity do not happen immediately (i.e., < 36hrs) upon exposure to food-input in abyssal sediments. Overall, the results from this case study reveal the key role of bacteria in the initial degradation of fresh phytodetritus at the seafloor in abyssal mesotrophic environments, and emphasize the differences that can exist in terms of short-term C-cycling processes in different abyssal environments (e.g., mesotrophic vs. eutrophic).

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