

## **Circulation and Transport associated to a Branch of the North Atlantic Current in the eastern part of the Subpolar Gyre.**

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The Overturning in Subpolar North Atlantic Program (OSNAP) is an international collaboration with the overarching goal of measuring the full-depth mass fluxes associated with the AMOC (Atlantic Meridional Overturning Circulation), as well as meridional heat and fresh-water fluxes. Through the deployment of moorings and gliders, UK-OSNAP is part of this international partnership to maintain a transoceanic observing system in the subpolar north Atlantic (the OSNAP array).

We present here the first 2 years of UK-OSNAP glider missions on the Rockall Plateau in the North Atlantic, along the section located at 58°N and between 22°W and 15°W. From July 2014 to July 2016, 15 gliders sections were realized on the Rockall Plateau. The depth-averaged current estimated from gliders shows very strong values (up to 45cm.s<sup>-1</sup>) associated with meso-scale and submeso-scale variability due particularly to eddies and subpolar mode water formation in winter.

The variability of the flow on the eastern slope of the Iceland basin and on the Rockall Plateau is presented. Meridional absolute geostrophic transports are calculated from the glider data and we will discuss the vertical structure of the absolute meridional transport, especially the part associated to the North Atlantic Current.

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## **Bioaccumulation of Persistent Organic Pollutants and Trace Metals in Scottish Marine Food Webs and their Relationship with Trophic Level and Fatty Acid Signatures.**

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### **Overview:**

The Water Framework Directive (WFD) has introduced Environmental Quality Standards (EQS) for a number of contaminants in biota while other processes have also produced assessment criteria including Background Assessment Concentrations (BACs) and Environmental Assessment Criteria (EACs). In order to undertake marine assessments using data from across the foodweb, the data sets need to be normalised to trophic level 4 (this represents the species that can most easily be obtain in sufficient numbers on a regular basis). The concentration of persistent organic pollutants (POPs) and trace metals will be determined in a variety of targeted species at different trophic levels across the marine food web. Fatty acid signatures will be determined by gas chromatography-mass spectrometry (GC-MS). Stable isotope ratios ( $^{15}\text{N}/^{14}\text{N}$  and  $^{13}\text{C}/^{12}\text{C}$ ) determined by CN Isotope Ratio Mass Spectrometry (IRMS) will be used, together with the fatty acid signatures, to identify the feeding pattern of organisms and accurately determine their trophic position. Samples have been collected from 5 areas around Scotland covering from trophic level 1 (primary producers e.g. marine phytoplankton) to level 4 (whiting and dogfish). Trophic level 5 (porpoises, dolphins, whales and seals) will be covered by samples collected by the Scottish Marine Animal Strandings Scheme. The relationship between the trophic position and contaminant concentrations will be assessed and trophic magnification factors (TMF) calculated. The TMFs will be calculated and applied to the concentrations of POPs and trace metals to investigate the effect this has on the assessment of the data against the relevant assessment criteria (e.g. EQSs) and ultimately establish whether this methodology can be used to assess environmental status.

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## Ecotoxicology of sunscreen on tropical corals in a changing ocean

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Between 4,000 and 6,000 tons of sunscreens are released into reef areas annually, with the majority being concentrated around popular tourist destinations. UV filtering compounds found in many sunscreens have been documented to have negative impacts upon corals in terms of their development at the planulae stage and by promoting viral infections leading to bleaching. Mineral sunscreens (containing ZnO and TiO<sub>2</sub>) are now more commonly used than chemical sunscreens and were thought to be less harmful to corals (Cole et al., 2012). However, evidence is emerging that nano-particles (NPs) of TiO<sub>2</sub> can increase stress in corals causing the expulsion of symbiotic algae and an increase in heat shock protein (HSP) expression. Similarly, ZnO NPs can also have negative effects on marine algae and invertebrates with recorded increases in superoxide dismutase, metallothionein and HSPs (Wong et al. 2009; Tang et al. 2013). Commonly available mineral sunscreens currently contain varying sizes of ZnO and TiO<sub>2</sub> from the nano- to the micro-scale, some of which are coated to reduce photodegradation, which leads to different effectiveness, but also different fate and potential environmental effects. In this study we explore how TiO<sub>2</sub> and ZnO NPs impact upon the growth, physiology and Reactive Oxygen Species (ROS) production of the host coral and isolated and *in hospite Symbiodinium* (the symbiotic microalgae within coral) under projected future ocean conditions.

### References

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# The Feeding Ecology of Grey Gurnard, *Eutrigla gurnardus*, off the coast of Scotland

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Until recently, little research had been conducted into the feeding ecology of grey gurnard (*Eutrigla gurnardus*), and the species' wider interaction with the ecosystems it inhabits. This study was carried out to address several questions that have recently arisen about the species, the main question being whether the grey gurnard population at Rockall Bank have been preying on the juvenile haddock (*Melanogrammus aeglefinus*) to a degree that has caused the haddock stock to decline. This was assessed by conducting a stomach contents analysis on a sample of grey gurnard caught on several trawls. The results of this were inconclusive, with only 3 stomachs containing potential haddock remains out of a total of 121 stomachs. However, these results do not completely disprove the hypothesis, as other factors may have influenced the low fish intake in these gurnard. Furthermore, the populations of grey gurnard from Rockall Bank and the Firth of Forth were compared to determine any differences in feeding ecology between the two. It emerged that the two populations were reasonably similar, with smaller size classes consuming less fish and proportionally more invertebrates, while larger size classes had a diet that was predominantly fish, with the fish prey consisting largely of sandeels (*Ammodytes marinus*). Finally, the influence of fish size on prey selection was investigated, with the result showing a clear correlation between increasing fish size and increasing prey mass, likely owing to the greater amount of fish prey compared to invertebrate prey that makes up a larger gurnard's diet.

## Acknowledgements

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## Identifying the effect of trawl intensity on mobile megafauna associated with Burrowed Mud

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Trawling has been identified as one of the main causes of human disturbance affecting benthic habitats, reducing the biomass and productivity of many benthic invertebrates and changing the benthic community structure. “Sea-pen and burrowing megafaunal communities”, also known as “Burrowed Mud” has been identified by OSPAR as a threatened or declining habitat in the North Sea and Celtic Seas. The condition of Burrowed Mud communities is ecologically significant because the burrowing benthic fauna act as ecosystem- engineers creating habitat for other organisms. A common burrowing species found on Burrowed Mud is *Nephrops norvegicus*, a commercially targeted species in the NE Atlantic. The overlap of this fishery with a habitat designated as threatened requires information on the habitat and its associated species to inform management decisions. In this study stereo baited remote underwater videos are used to estimate the abundance of mobile megafauna on Burrowed Mud habitat that have been exposed to different levels of trawl intensity off the West Coast of Scotland. The aim of this study was to determine if baited cameras could be used as a non-destructive method for monitoring mobile megafauna communities on Burrowed Mud and to identify species which are sensitive to fishing pressure that could be used in metrics for monitoring recovery in areas proposed for protection. Trawling intensity was negatively related to species richness of mobile megafauna, and the presence of *Munida rugosa*, *Cancer pagurus* and *Liocarcinus depurator*. No relationship was found between trawl intensity and the presence of deep burrowers (*Nephrops norvegicus* and *Goneplax rhomboides*). Hence, this study suggests that burrowing crustaceans are less vulnerable to the impacts of trawling than those that do not burrow. This gives support to the use of biological traits as indicators to detect changes of communities to fishing pressure.

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## Habitat selection of the spiny lobster *Palinurus elephas* (Fabricius, 1787): preliminary results

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The first known written description of the species was from Aristotle almost 2,600 years ago. The spiny lobster (well known as crawfish or crayfish) inhabits hard bottom habitats as deep as 200m. Spiny lobsters are omnivorous, gregarious and predominantly nocturnal animals. The species generally demonstrates limited mobility, but the Atlantic population undertakes a reproductively driven onshore migration. It is a vulnerable species and it is included at the IUCN Red List of threatened species. The species occurs in European waters (other: *P. mauritanicus*) from North Atlantic Ocean, throughout Mediterranean as east as Aegean Sea. Furthermore, the species is an important fisheries component in several countries across its geographical distribution.

To provide a systematic understanding of habitat requirements and associated behaviours of this species, a series of experiments are in progress. Substrate, preference or selection experiments were conducted in continuous darkness using four distinct substrate types. Infrared CCTV was used to record the position of experimental animals.

The preliminary results indicate habitat preference among individuals and between day and night. This experiment will contribute to the wider assessment of the species restoration potential within Marine Protected Areas and *de facto* MPAs such as offshore windfarms.

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## Potential interactions between migratory fish and marine renewables in Scotland.

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Atlantic salmon (*Salmo salar*) are an iconic and economically important fish; however, their migratory behaviour during passage through Scottish coastal seas is not well understood. This means there are unanswered questions about the potential for interactions between migrating salmon and marine renewables. Will migrating fish encounter renewable energy devices as they pass through areas where development is planned, and what will be the outcome of these encounters? In order to explore these questions, the Pentland Salmon Initiative aims to engage organizations with interests or experience relevant to marine renewables and salmon migration, and we welcome opportunities for collaboration with new partners. Our initial focus is the Pentland Firth: a potential bottleneck for migrating salmon and a key site for the developing marine energy sector.

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