New, exciting and unexpected ways to measure light absorption in the ocean

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Sunlight provides energy to the marine environment through visible and infrared radiation which is absorbed by the seawater and constituents within. Absorption in the infrared region plays a key role in global solar heating while visible radiation sustains marine algae, driving photosynthesis and primary production, the first link in the marine food web. Light absorption determines how light propagates under water and as a result shapes the water-leaving radiance which is a major contributor to remote sensing signals. It is important to collect information on spectral absorption properties of marine waters to understand and monitor bio-optical processes on a variety of different scales - from single cells to entire ocean basins.

Various different spectrophotometric techniques are routinely used to measure absorption spectra from water samples which help to gain insight into the dissolved and suspended materials present. However, all instruments and methods to determine absorption are affected by a combination of different measurement uncertainties, including susceptibility to scattering errors, signal-to-noise limitations or stability issues, to varying extents.

Over the past decades, optical oceanographers developed new sensors and methods as well as correction schemes for existing techniques, leading to the reduction of measurement uncertainties and an improvement in absorption data quality. For example, the precision of absorption measurements for discrete samples was significantly improved by using systems with longer optical pathlengths, such as LWCCs (liquid waveguide capillary cells; Lefering et al., 2017) or PSICAMs (point-source integrating cavity absorption meters; Röttgers et al., 2005). Furthermore, new techniques and correction methods have improved the quantification of absorption by particulate matter, such as phytoplankton or detritus (Stramski et al., 2015; Röttgers et al., 2016).

In addition, great effort has gone into the development of scattering correction methods for in situ determinations with submersible sensors (McKee et al., 2013). In situ absorption can also be derived from measurements of different parameters of the underwater light field, using Gershun’s equation. This non-spectrophotometric method, has been used in very few studies in the past (Voss, 1989) because it requires radiometric data which is not commonly measured. During fieldwork conducted in the Indian River lagoon, Florida, in January 2017, we were able to measure the full set of radiometric parameters required for the calculation of absorption coefficients.

In this work, we will present a variety of different methods to measure spectral absorption coefficients in situ (including absorption spectra derived using Gershun’s law) as well as from discrete water samples.

References


Ecological Enhancement of Coastal Infrastructure

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Are you a student? : Yes

Globally, the coastal zone is under increasing pressure with rising sea levels driving coastal erosion and flooding which, together with coastal urbanisation, has major implications for coastal ecology and society and producing a worldwide proliferation of hard engineering structures. However, such structures do little to replicate the topographic complexity and microhabitats found on natural rocky shores. They offer poor ecological surrogates for the natural environment, largely due to the physical differences between coastal armouring and natural shores (Firth et al., 2014).

Ecological enhancement can improve the sustainability, resilience and multifunctionality of hard urban infrastructure (Naylor et al., 2012), mitigating some of the negative effects of construction.

In the largest UK experiment of ecologically enhanced surface designs, 184 test tiles (15 by 15 cm) were deployed on vertical concrete coastal infrastructure at three sites across the UK. Surface texture and complexity were varied to test the effect of settlement surface texture on the success of colonisation and biodiversity in the mid-upper intertidal zone using ecological and biogeomorphological theory. Tile designs included terrestrial laser scanning of creviced rock surfaces to mimic natural rocky shore complexity as well as artificially generating complexity using the computer software ‘Complexity for Artificial Substrate’ (CASU) (Loke et al., 2014). The different designs replicated topographic features of high ecological importance that are found on natural rocky shores and promoted species recruitment and community composition on artificial structures (Firth et al., 2014).

Tiles were photographed at 2, 6 and 12 months post-installation. There was shown to be no statistical difference in settlement between the 2, 6 and 12 month periods. An ANOVA was performed using the barnacle count data on n=4 tile designs and clearings that were deployed across all three sites. Results from the ANOVA showed that texture treatment had a significant influence on barnacle abundance (p<0.001), with significantly fewer barnacles settling on plain-cast controls compared to tiles with mm-scale texture. Interactions between the effects of site depended on tile type (p<0.001). Four other tile designs were used in this study but these vary in their installation locations and so further statistical analysis will be undertaken for within site comparisons using a subset of the data.

Tiles with cm-scale complexity showed greater species richness, with several periwinkle species and topshells frequently utilising tile microhabitats in greater numbers than mm-scale designs. Statistical analysis of species richness data is being undertaken at present.

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References
Characterization of 32 microsatellite loci for the sea urchin *Psammechinus miliaris* (Echinodermata: Echinoidea: Parechinidae) using Illumina paired-end sequencing

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One of the most useful techniques to determine connectivity between natural populations is based on a combination of genetic analysis. Microsatellites, defined as simple sequences repeats (SSR), are highly polymorphic and codominant markers, used for populations studies where the question involves detecting connectivity patterns or changes in the recent past (0-100 generations) (Griffiths, 2013).

As the first step in order to determine the genetic structure and connectivity between populations of the sea urchin *Psammechinus miliaris* around the United Kingdom, 32 microsatellite loci were isolated using bioinformatics pipeline for microsatellite development from Illumina paired-end sequences. *Psammechinus miliaris* is a common regular sea urchin distributed around the British Isles, as far north as Scandinavia and south to Morocco. It lives in sheltered areas of sea lochs or exposed to air at low spring tides (Kelly et al., 2013).

Microsatellites were tested in eight individuals found to the east side of Fraoch Eilean (UK), following the respective steps of DNA extraction, library preparation and sequencing, the design of microsatellites using Centaurus Galaxy Server and PCR amplification of selected loci. Process was performed at Molecular Laboratory of Manchester Metropolitan University.

To further determine the utility of those markers for assessing population genetic diversity, polymorphism levels should be checked in 103 samples that were collected at 6 localities around the United Kingdom, which will show the variation present at each locus.

With this results, we design per first time an important number of molecular markers for this sea urchin.

This method recently reported by Griffiths et al. (2016) is effective for developing markers in a more rapid and cost effective manner, as well as allowing a greater choice in the type of microsatellites to be developed.

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References

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Identifying fishing behaviours of inshore fishing vessels targeting crabs and lobsters around Scotland

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Spatial management of the marine environment should underpin sustainable management of the ecosystem including vulnerable and dependent species such as marine mammals, commercial resources such as fish, and human communities that depend on the marine environment for their way of life. Management measures may result in restriction of fishing effort e.g. through closure of areas. To predict impacts of such measures on people and marine species, it is essential to know how fishing is currently distributed and how intense levels of fishing are at local scales. However, the distribution of fishing activity in inshore areas (often carried out by small scale fishing vessels) is currently not well known, though tracking data from AIS and GPS systems are increasingly available. Tracking data can be analysed to indicate the location and speed of boats in time and space, but it is not possible to directly infer where boats are fishing or where they are engaged in other activities (such as travelling to and from their fishing grounds). Patterns of movement associated with particular types of fishing may be detectable e.g. characteristic patterns of speed and turning behaviour when creels are deployed or retrieved. We will present initial results of an analysis of boat movement data for which there is matching on-board validation of activities during a fishing trip, allowing us to model the association between movement patterns and fishing. We then use a cross-validation procedure to evaluate the model performance by splitting the ground-truthed data into two datasets. The first dataset is used to estimate model parameters and the second, to validate the models by estimating model performance, by assessing the percentage of events in which the predicted behavioural state corresponds to the true behaviour.

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Variation in selection pressures induced by complementary and conflicting benthic ecosystem engineers

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Extended Evolutionary Synthesis theory predicts that, through their niche construction, organisms greatly influence community structure, stability and productivity, and co-direct evolutionary responses to selection in ecosystems (Odling-Smee et al., 2003; Laland et al., 2015). The degree to which niche constructing activities are synergistic or conflicting impacts the magnitude and stability of biochemical and physical gradients formed within sediment profiles. These gradients generated by the niche constructors are selective pressures to microbial communities in sediment.

The aim of this work was to test how synergistic and conflicting niche constructing activities alter functional outcomes and biochemical gradients in mesocosm systems. Dissolved oxygen concentrations and redox potential influence microbial community structure, diversity and function, ultimately effecting ecosystem services such as nutrient cycling and carbon storage.

A well-established mesocosm system (Emmerson et al. 2001) with treatments containing neither, one, other, or both Corophium sp., Nereis diversicolor, or manual turbation was constructed. Functional outcomes of NH₄-N flux, sediment stability, extracellular polymeric substance and chlorophyll content were analysed. In addition, dissolved oxygen and redox potential gradients in sediment to a depth of 5 cm were measured every 7 days with slender-design Clark-type microsensors.

Different niche constructor combinations altered selective pressures on microbial communities. The results support extended evolutionary synthesis theory that organisms co-direct selection pressures in ecosystems.

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References


Baited camera lander attracts flapper skates (*Dipturus cf. intermedia*) for photo-identification

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Flapper skates (*Dipturus cf. intermedia*, formerly combined with Blue skate *D. flossada* as Common skate *D. batis*) are currently classified as Critically Endangered throughout their habitat range due to historic and ongoing fishery-related overexploitation (Brander 1981; Dulvy et al. 2006). In the UK, small relic populations survive in inshore Scottish waters (Neat et al. 2015). Flapper skates can be individually identified using dorsal pigmentation patterns, allowing development of a photo-identification catalogue for assessment of presence, distribution, survival and other biological parameters (Benjamins et al., submitted). Images of individual skates have, however, typically been collected from sea angling records which can introduce inadvertent biases (e.g. non-random geographical sampling distribution, inadvertent selection of particular size/age classes).

To determine whether current efforts at building a skate photo-ID catalogue on the basis of sea angler photos are biased, we deployed a baited camera lander within the *Loch Sunart to Sound of Jura* Marine Protected Area (MPA) set up for flapper skates in western Scotland, UK. The aim was to test whether flapper skates could be attracted for long enough to collect high-quality images allowing individual identification and comparison of free-swimming skate to the existing photo-ID catalogue (Whitmarsh et al. 2017).

Flapper skates were successfully attracted to the baited camera lander on at least seven occasions during 5 deployments (totalling approx. 10.5 hours). At least four different individuals could be visually identified by comparing dorsal pigmentation patterns, none of which matched existing records in the photo-ID catalogue based on angling images from nearby areas. These initial data suggest that spatially restricted recreational angler-based sampling efforts might indeed underestimate skate presence across the whole MPA.

Baited camera landers can provide novel insight into flapper skate presence and distribution in situ, independent of fishing and angling efforts. This approach offers significant potential in clarifying flapper skates’ individual movement and residency patterns and should provide a valuable tool for monitoring the success of the MPA.

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**References**


