The relationship between oysters and microscopic benthic algae revealed by satellite remote sensing

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Primary production in estuarine and coastal mudflats is largely provided by assemblages of unicellular, benthic algae commonly referred to as microphytobenthos (MPB). Despite their microscopic size, these tiny algae form photosynthetic biofilms visible by satellite remote sensing (RS), thanks to their special optical characteristics. This makes RS a great tool to analyse MPB spatio-temporal variability, bringing to light the mechanisms behind it. Yet not all processes, e.g. interactions with higher-level benthic communities, are fully understood. In the context of the growing impact of invasive species, we analysed the influence of feral *Crassostrea gigas* oysters on MPB biofilms. A life-size experiment was conducted to evaluate the effect of oyster elimination on surrounding MPB, by burning the oysters from a reef within a mudflat. The impact of the experiment was assessed thanks to a unique 30-year time series (1985-2015) combining Landsat and SPOT satellite data, using the normalized difference vegetation index (NDVI). Seasonal signals were also extracted from this extensive time series. Our results clearly showed the promoting influence of oyster reefs on MPB spatial distribution. Thanks to the high resolution (30 m) of the historical time series, persistent, highly concentrated MPB patches surrounding oyster reefs were first highlighted. Secondly, the field experiment revealed oyster elimination's negative impact on both MPB biofilm structure and concentration. This confirmed that the relationship between MPB and oysters is not limited to a bottom-up control, but that oysters actually play a positive top-down control on MPB biofilms. The hypothesis of nutrient inputs has been advanced as an explanatory factor, where oyster organic matter released through excretion and biodeposition would stimulate MPB growth. MPB also showed marked seasonal variations associated to changes in patch shape, size and degree of aggregation around oyster reefs. These variations, with higher NDVI occurring during spring and fall, were consistent with those observed at broader scales in other European mudflats. This study provided the first evidence of oyster reefs' positive effect on MPB biofilms using a RS satellite multi-sensor time series.

Keywords: microphytobenthos; satellite remote sensing; oyster reefs; NDVI