MASTS Biogeochemistry Forum Small Grant Scheme

MBFSG46: Quantifying real-time inorganic carbon production through respiration and calcification by Ostrea edulis (Hannah Lee, Heriot Watt University)

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Project overview and background

Bivalve habitats are at risk, with populations having undergone extensive historical degradation due to disease, overfishing and habitat disturbance (Beck et al., 2011; Laing et al., 2006; Thurstan, 2013; zu Ermgassen et al., 2021). As a result, the benefits which would otherwise be provided by intact habitats are considerably diminished, such as water filtration, food security and nutrient cycling among other ecosystem services (ESs) (zu Ermgassen et al. 2020a). At current, extensive knowledge gaps remain regarding the delivery of ESs by European flat oyster (*Ostrea edulis*) habitats (Lee et al., 2020; van Der Schatte Olivier et al., 2018; Zu Ermgassen et al., 2020[a]). This includes the role of European flat oysters in carbon storage, in particular, further understanding of the pathways of carbon deposition and loss in these systems, the balance between these pathways, as well as the long-term fate of accreted carbon (Lee et al., 2020). When considering carbon and bivalve's, inorganic calcium carbonate has commonly been the focal topic, with particular regards to the balance of carbon deposition and release during the process of calcification (Frankignoulle et al, 1994; Fodrie et al., 2017; Macreadie et al. 2017). Bivalve beds are a matrix of both sediment and calcium carbonate deposits (Fodrie et al. 2017; Lindenbaum et al. 2008). The deposition of sediments is facilitated by both active deposition (biodeposition of faeces and psuedofaeces) and passive deposition (Lee et al. 2020; Kent et al., 2017). In order to formulate an appropriately balanced carbon budget, both the release of carbon through respiration and calcification as well as carbon deposition through shell growth and sediment deposition must be considered.

Previous work (Lee et al. 2020) conducted at St Abbs Marine Station, Scottish NE coast, demonstrated through biodeposition alone the European flat oyster has the potential to treble the transport of carbon from seawater to seafloor, enhancing benthopelagic coupling. Alongside this work, ex-situ incubation studies were undertaken to quantify immersed calcification and respiration rates. Chambers with and without oysters were incubated for 6 hours (replicated over 3-days). Samples were spiked and stored and subsequently analysed (see zu Ermgassen et al. 2021) at The Scottish Association for Marine Science and the University of Edinburgh for total dissolved inorganic carbon (UIC Coulometer) and total alkalinity (Gran Titration).

Summary of analysis funded by the grant

The funds awarded (Table 1) by the MASTS Biogeochemistry Forum contributed to the cost of analysis of water samples acquired during incubation studies. This included standards, to ensure analysis accuracy, and cost of analysis.

Table 1. Summary of costs for water samples analysis

Procurement	**Cost**
DIC Analysis + TA Analysis	519.18
Dickinsons seawater standard	188.80
Total contribution	707.98

Results, outputs, and benefits to the MASTS community

The data acquired will be presented in the authors PhD thesis and is currently being prepared for publication.

The quantification of the measured changes in both total alkalinity and dissolved inorganic carbon in water samples collected during incubation studies enabled the rate of both respiration and calcification rate of the European flat oyster to be examined. The wider study has then set-out to combine these data with measured rates of biodeposition as a result of the filtration of European native oysters (Lee et al. 2020) to enable further understanding of the carbon budget of the European native oyster.

The research outputs align with the MASTS research theme *'Marine Biodiversity, Function and Services',* as well as contributing towards the current research themes of Scottish government to '*better understand blue carbon and how it can help us mitigate and adapt to climate change'*.

Quantification of ESs recovery is a powerful tool for supporting the business case for restoration, however at current extensive knowledge gaps remain regarding the provision of ESs by a species at the focus of international restoration efforts (see zu Ermgassen et al. 2020b). Further to the direct benefits to the MASTS community, the wider study provides an opportunity to examine a more complete carbon budget of the European flat oyster, a key interest to the Native Oyster Restoration Alliance (NORA), and the Native Oyster Network (NON). The conclusions of this study will benefit 30+ European flat oyster restoration projects throughout Europe as well as partners in the USA, Australia and beyond.

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