Integrated Multi-trophic Aquaculture System for Sustainable Aquaculture and By-Product Valorization: First Application of this Innovative Blue Biotechnology in Albania

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Abstract

The Blue Biotechnology (BBt) sector can have a significant impact on the environment, human wellbeing and economic growth, however in the Mediterranean basin it is currently in its infancy. B-Blue project has built a preliminary network of actors related to BBt and analysed best practices, key drivers, barriers and readiness factors of Euro-Med companies for adopting blue biotechnologies, concluding with the most promising value chains for Euro-Med area. The project allowed the establishment of 5 interactive Blue Biotechnology Hubs (BHHs) to facilitate collaborations, knowledge transfer and spill-over effects to spur innovation and business within the marine biotechnology value chains and address the challenges detected. The Albanian pilot focuses on strengthening sustainable aquaculture value chains through the development and implementation of Integrated Multi-trophic Aquaculture (IMTA systems) in the Bay of Vlora. By integrating species from different trophic levels—such as fish, shellfish, and holothurians —the pilot promotes nutrient recycling, reduces environmental impact, and improves water quality. This approach enhances the aquaculture products value chain by transforming waste into valuable biomass, supporting the production of high-value products for food, feed, and other bio-based sectors. Actually, we have designed an *ad-hoc* system and improved it during the installation in the Alb-Adriatico 2013 shpk aquaculture farm, where are present 2 demonstrative units (DU), one for each of the aquaculture commercial species, gilthead seabream and European seabass. Here we are going to present the preliminary results during the monitoring in the Demo Site (DS).

Introduction

Aquaculture has recently overtaken fisheries as the largest producer of seafood products for human consumption and consequently the development of innovative methods to manage some of its environmental impacts (e.g., release of nutrients in the environment) has received more attention (FAO, 2022). Even if the replacement of wild stock fisheries by aquaculture sounds positive, several factors have to deeply change to render it sustainable and respectful of the environment (Hishamunda et al., 2009). The Integrated Multi-Trophic Aquaculture (IMTA) system has been developed to improve sustainability in intensive aquaculture facilities, combining fed aquaculture species with additional commercially relevant organisms, capable of extracting organic and/or inorganic compounds from the surrounding seawater (fish farm waste), creating a balanced system to promote environmental sustainability (biomitigation), economic stability (product diversification), and social acceptability (better management practices) (Biswas et al., 2020; Chopin et al., 2001; Troell et al., 2009).

IMTA originated in China and has since been taken up in North and South America, Africa, and Europe (Alexander et al., 2015). In our IMTA system, the IMTA organisms include bivalves and echinoderms that consume phytoplankton and particulate organic matter: 1. the Mediterranean mussel (*Mytilus galloprovincialis*), rayed pearl oyster (*Pictada imbricata radiata*) were co-cultured with fish; 2. As a consumer of the settling particulate matter, the sea cucumber *Holothuria tubulosa* was used as a deposit feeder, which can recycle the nutrients in the organic material settled on marine sediments. The primary objective of this study was to develop an IMTA methodology suitable for use in Adriatic Sea and particularly in the Bay of Vlora (Albania). The results can be used as a basis for setting up large-scale commercial IMTA systems in Albania and neighbor countries. This was a pilot study designed to examine the survival, robustness, and growth of the species *Mytilus galloprovincialis*, *Pinctada imbricata radiata*, and Holothuria *tubulosa* in IMTA systems (Figure 1).

Materials and Methods

The IMTA units were established in the Bay of Vlora, inside the aquaculture farm of Ald-Adriatico 2013 shpk. Inside the sea cages, the sea bream and sea bass are intensively farmed and fed with commercial fish feeds (pellets). Basket filled with IMTA organisms were installed in each of the IMTA units, while an IMTA unit was created for each of the farmed fish species. In the Figure 1 (on the right) are shown some of the photos, which were taken by ACEPSD members, during the installation and fine-tunning of the system, after doing the measurements of the organisms and water column parameters shown in Figure 2 and 3, respectively.

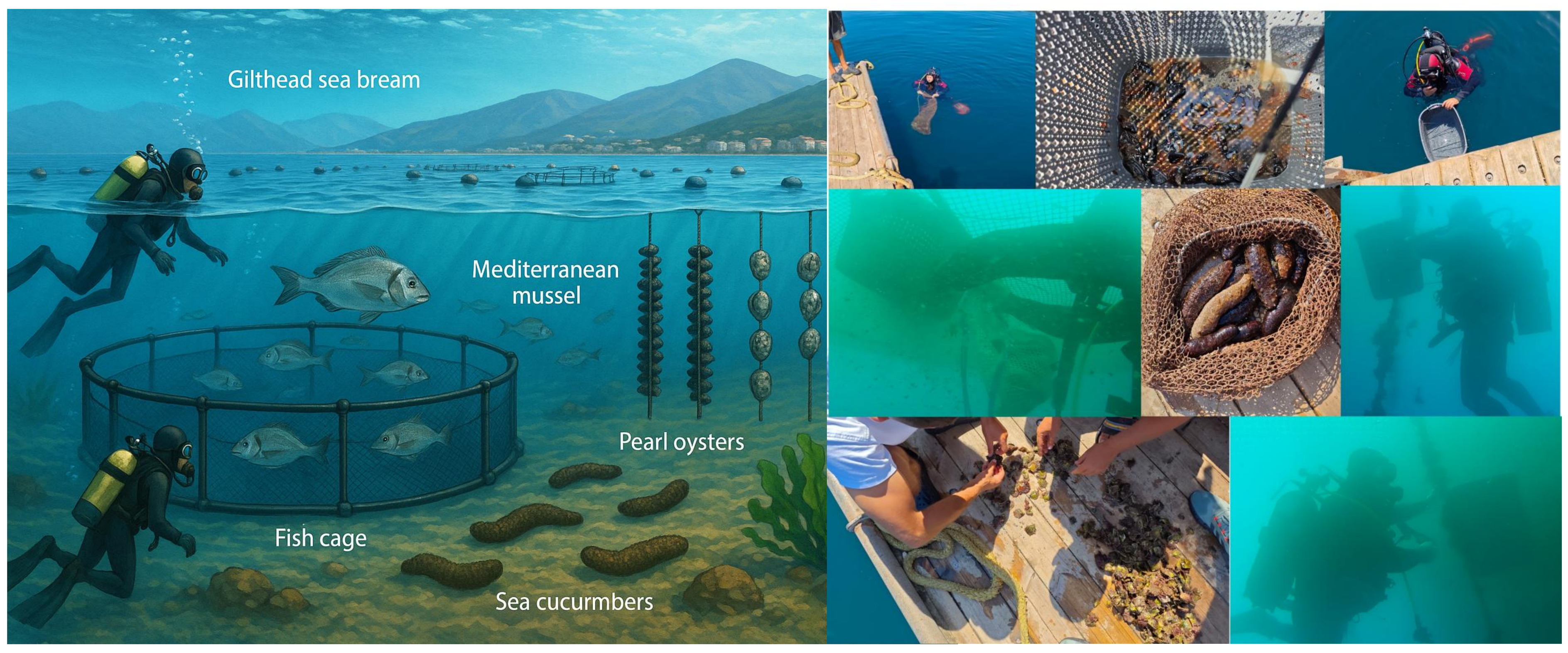


Figure 1. An illustration generated by AI about the established IMTA system in the Vlora Bay as a DS of 2B-Blue project (on the left) and photos during the establishment of IMTA units in the Vlora Bay (on the right); source: Rigers Bakiu

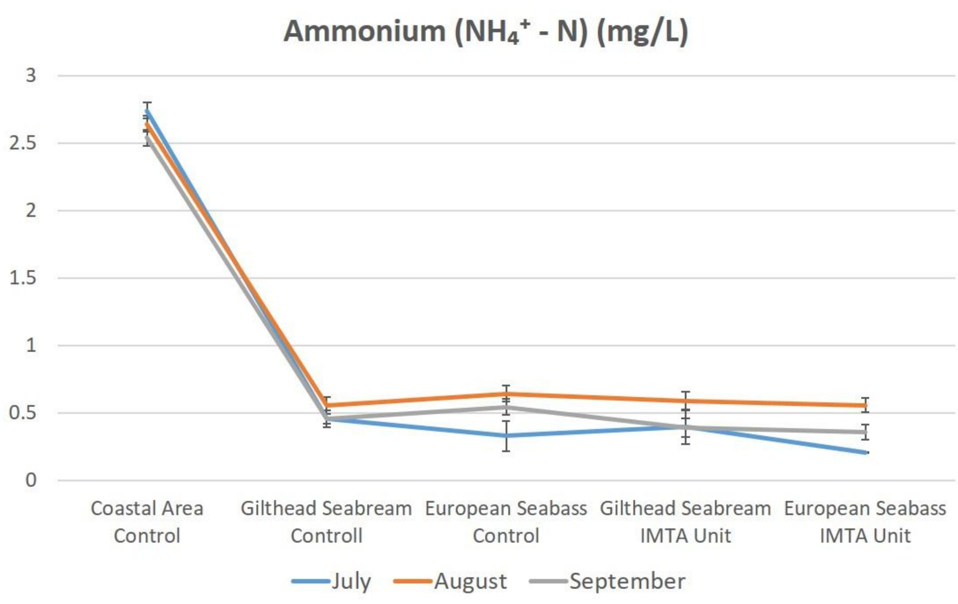
Results

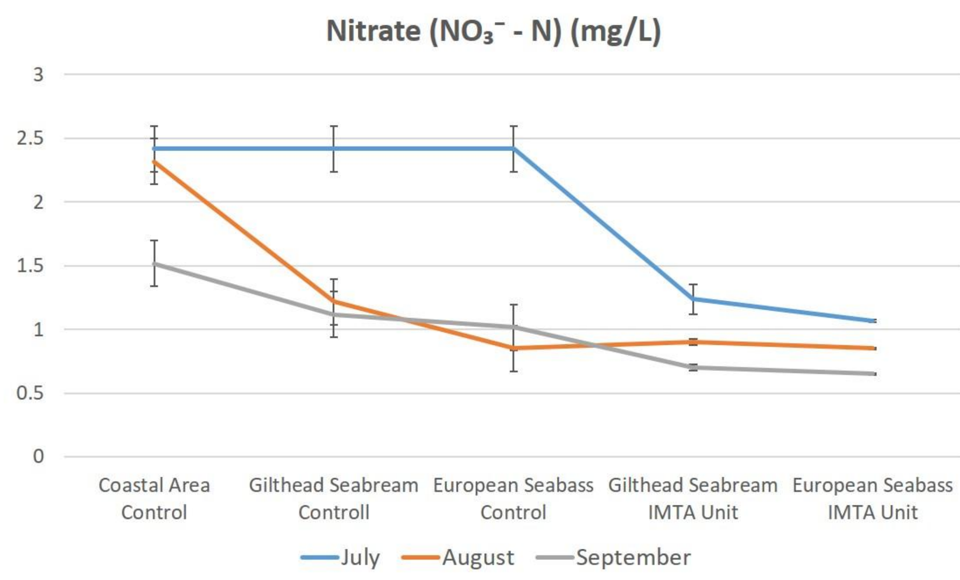
Previous to deploying the organisms in the relative baskets, their weight and other morphological measurements were conducted with the assistance of the divers and other employed staff members of the aquaculture company.

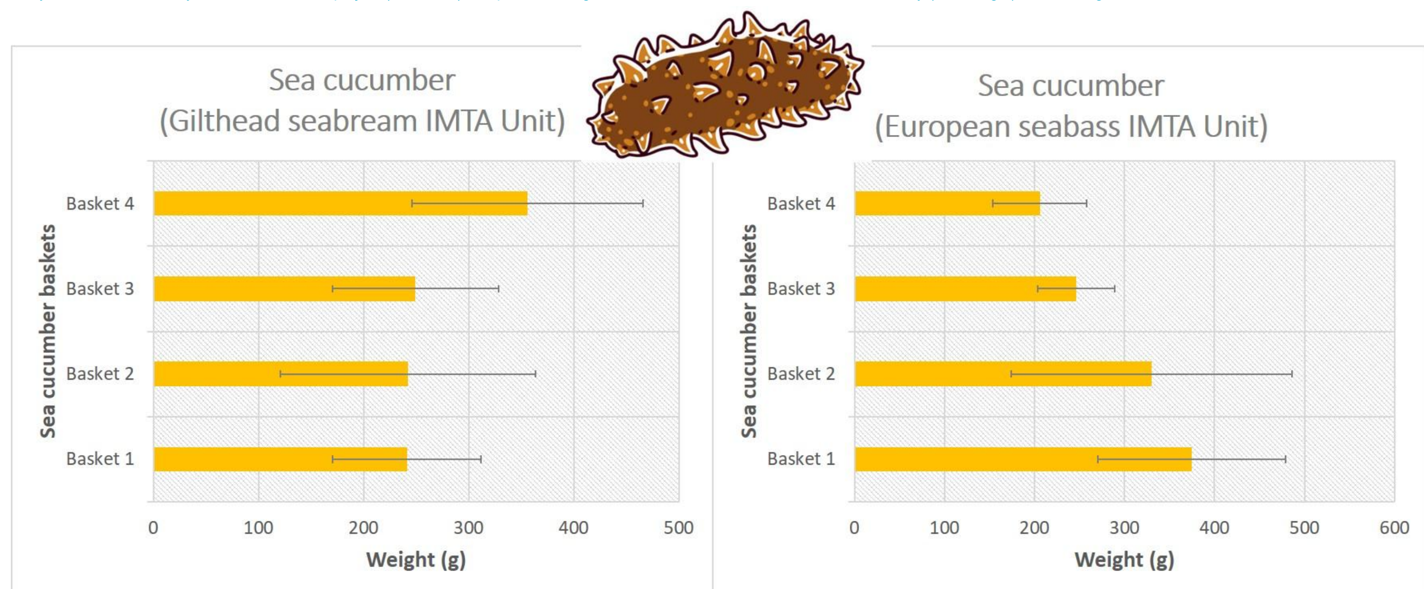
As it is shown in Figure 2. graphics, the average weights of sea cucumbers were different in the comparison between the baskets installed in each of the sea cages. Regarding the other IMTA organisms, Mediterranean mussel and rayed pearl oyster, as it shown by the graphics of Figure 2, there are small differences regarding the measured weight, in the comparison between the different installed baskets in each of the IMTA units.

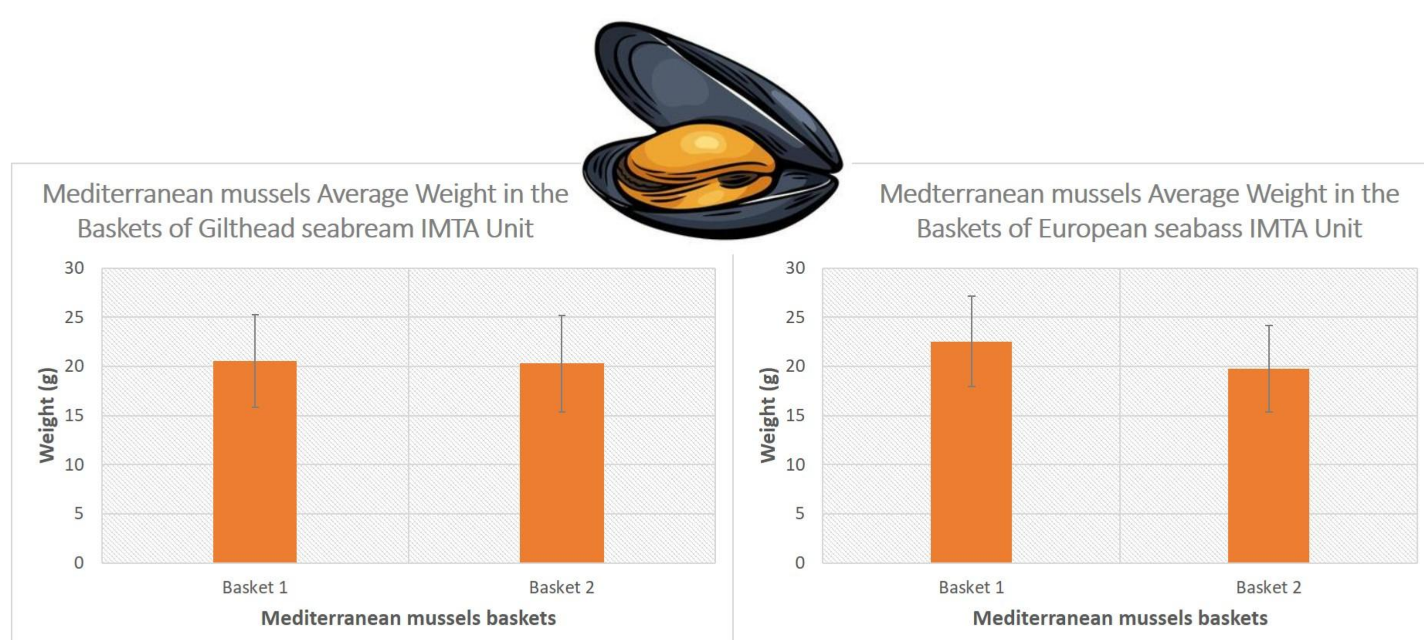
In addition, we conducted monthly measurements of water column parameters by using a multiparametric instrument responsible for measuring chlorophyll-a fluorescence (as an index of eutrophication) and the ammonium and nitrate concentration in different sites (close to the coast, in sea cages without the presence of the IMTA organisms and inside the sea cages of established IMTA units (Figure 3).

As it shown by the graphic showing the level of chlorophyll-a, it concentration is very low, except the case of the gilthead seabream IMTA unit, which average value was 3 RFU in July, though a decrease of its level was observed with the passing of the months. The most evident decrease (Figure 3) was observed regarding the nitrate concentration, while its concentration in the IMTA units was lower in comparison to the internal control since the month of July. The ammonia concentration didn't change on a similar way with the passing of the months.









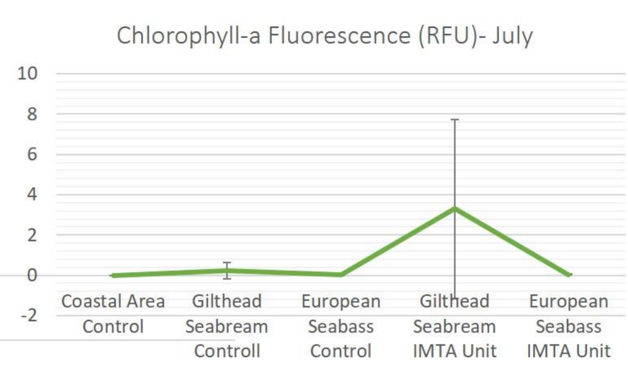


Figure 2. Graphics showing the average weight of IMTA organism in each of the IMTA units (on the right)..

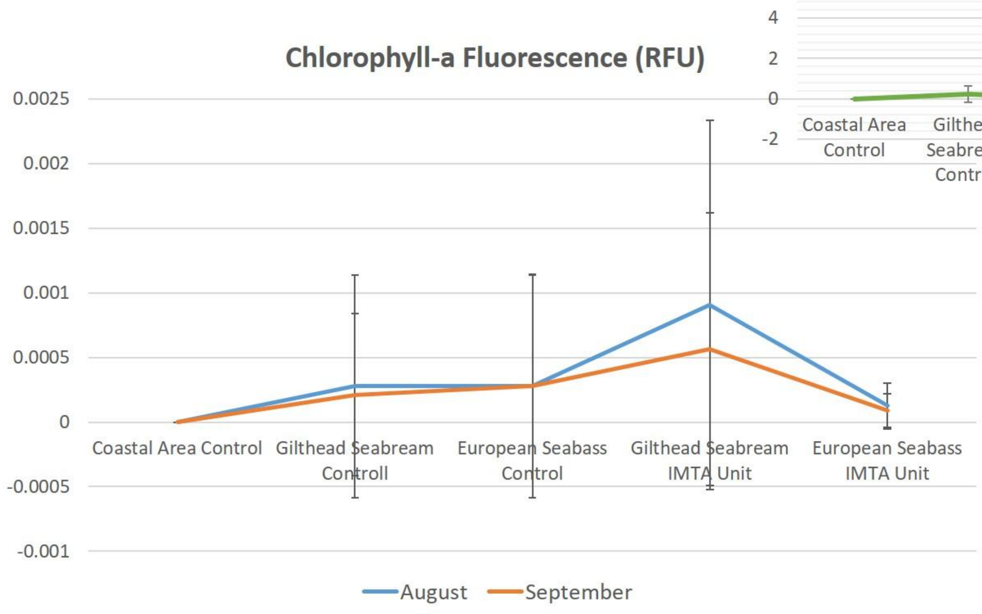
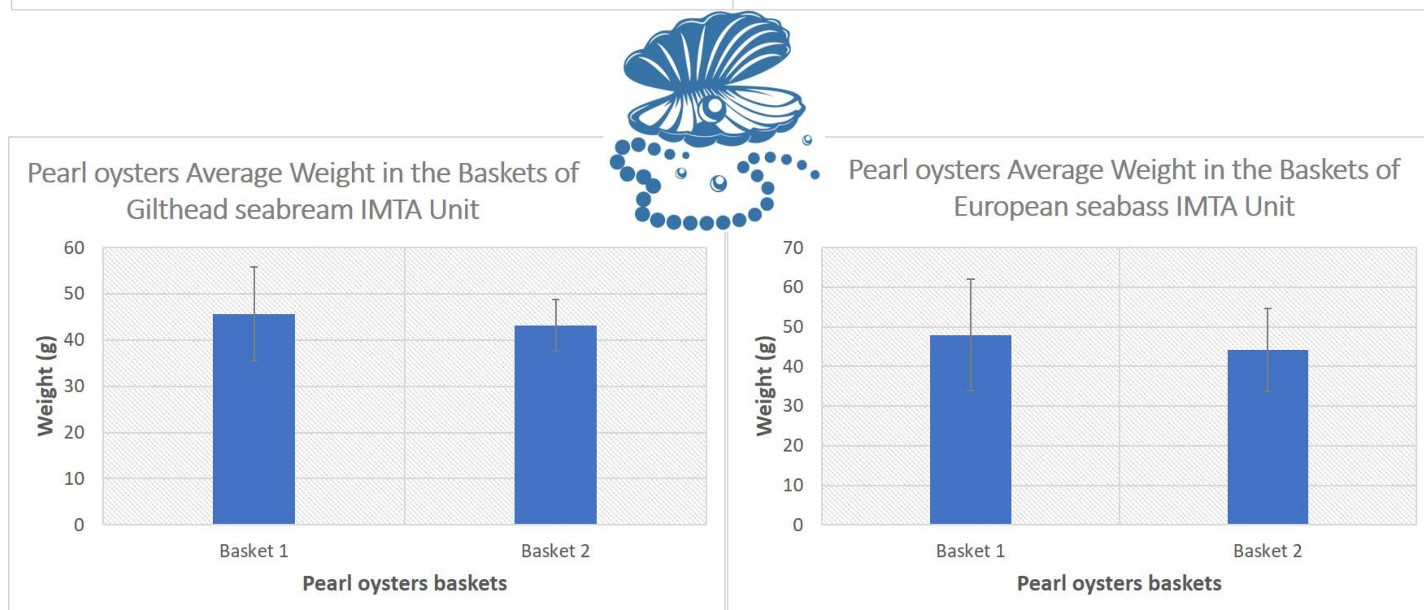


Figure 3. Graphics showing the average ammonium (on top), nitrate and clorophyll-a concentration in the different IMTA units and respective, internal and external control sites, during the 3 months monitoring.



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Future Perspectives

Actually, the expected results seem promising due to the observed decreasing ammonium and nitrate levels in the IMTA units in comparison to the internal and external control sites. It is expected at least for the Mediterranean mussel and rayed pearl oyster to obtain an increase in the average weight of growing specimens inside the baskets of the IMTA units.

Acknowledgements

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