



## ***Ulva* spp. as a biofilter for restorative aquaculture: supporting *Pinna nobilis* hatchery in IMTA systems**

Castelar B.<sup>1,2,3\*</sup>, Ferranti M.P.<sup>1,2,3</sup>, Di Napoli C.<sup>2</sup>, Asnaghi V.<sup>1,2,3</sup>, Comes A.<sup>2</sup>, Chiantore M.<sup>1,2,3</sup>

\*lead presenter: b.castelar@regenera-algae.it

1 RegenERA Soc. Coop., Italy

2 Department of Earth, Environment and Life Sciences (DiSTAV), University of Genoa, Italy

3 National Biodiversity Future Center (NBFC), Italy

Nowadays, aquaculture has undergone significant transformations, increasingly adopting more sustainable practices. Low-trophic organisms, particularly seaweeds, are now recognized as strategic components for regenerative aquaculture. Among them, *Ulva* spp. has emerged as one of the most promising seaweeds for integrated multi-trophic aquaculture (IMTA) systems due to its high nutrient uptake capacity, fast growth rates in tank-based production, and wide spectrum of industrial applications.

Beyond regeneration, aquaculture can also play a restorative role in the context of environmental crisis and biodiversity loss. In this study, we explored the potential of *Ulva* sp. as a biofilter to enhance water quality in the hatchery of the fan mussel *Pinna nobilis*, a critically endangered Mediterranean species. Semi-closed experimental systems were designed to evaluate whether *Ulva* sp. could efficiently remove dissolved nitrogen (N) and phosphorus (P) remaining compatible with *P. nobilis* rearing.

During entire experimental period the ammonia values were under safe limits for mussels in hatchery, up to 0.22 mg.L<sup>-1</sup>. Nutrient concentrations were reduced in 35% and 32% daily for N and P, respectively. The daily growth rate (DGR) of *Ulva* sp. averaged 2.75 ± 0.79 %·day<sup>-1</sup> in IMTA and 3.55 ± 0.79 %·day<sup>-1</sup> in the control, without significant differences (T = -1.24; p = 0.28).

Despite relatively low growth performance, *Ulva* sp. proved efficient in nutrient removal, maintaining water quality within suitable ranges for *P. nobilis* hatchery conditions. Importantly, the IMTA approach was safe for *P. nobilis*, with no evidence of negative interactions.

These findings highlight the dual role of *Ulva* sp. in regenerative and restorative aquaculture, supporting its use as a biofilter in conservation-oriented systems and as a tool to integrate sustainable production with biodiversity restoration, amplifying the ecological and practical applications of *Ulva* sp. in Mediterranean aquaculture.

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