

# Development of new experimental approaches for the study of the responses of marine organisms to multiple anthropogenic impacts

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Importance of the experimental approach in marine ecological research and how integrated research, through the use of aquaria and mesocosms in the field, can answer questions related to multi-stress and multi-impact conditions and what are the future needs. Environmental conditions are also changing in deep sea, which requires technological development allowing the maintenance of organisms of deep and extreme environments

Evaluate multiple anthropogenic impacts, including cumulative and synergistic impacts due to changes in T and pH, as well as identify new model organisms to evaluate responses to impacts. Through the development of mesocosms, the effect of contaminants on food webs (*Cystoseira sp.*, filter feeders, crustaceans) in different areas of the Central Adriatic will be evaluated.

Development of technological experimental systems for the maintenance of new models for scientific research with particular reference to ascidians.



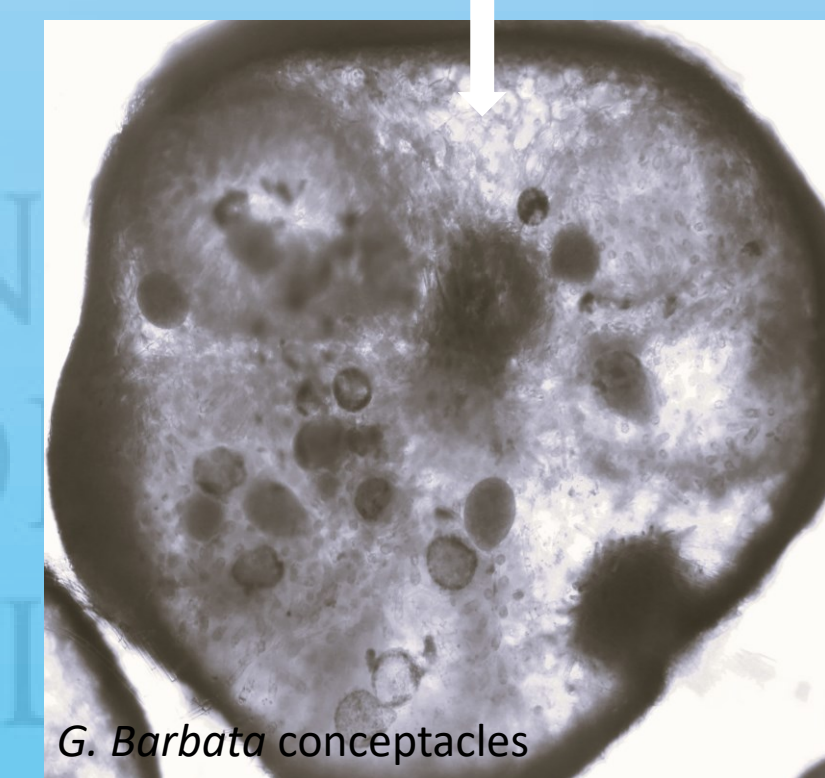
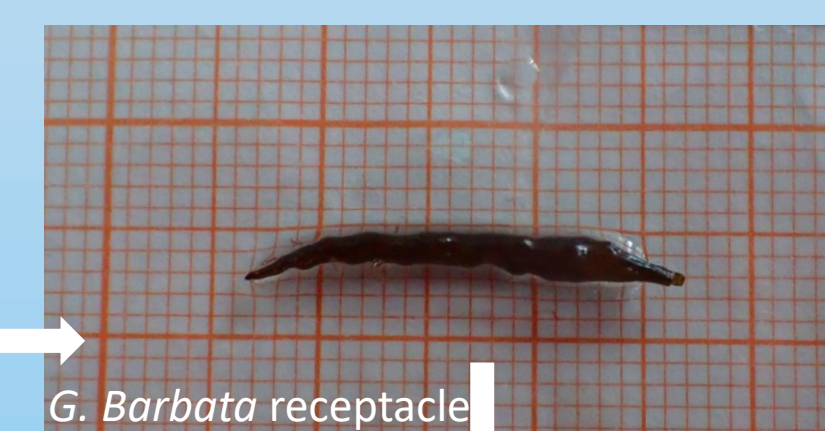
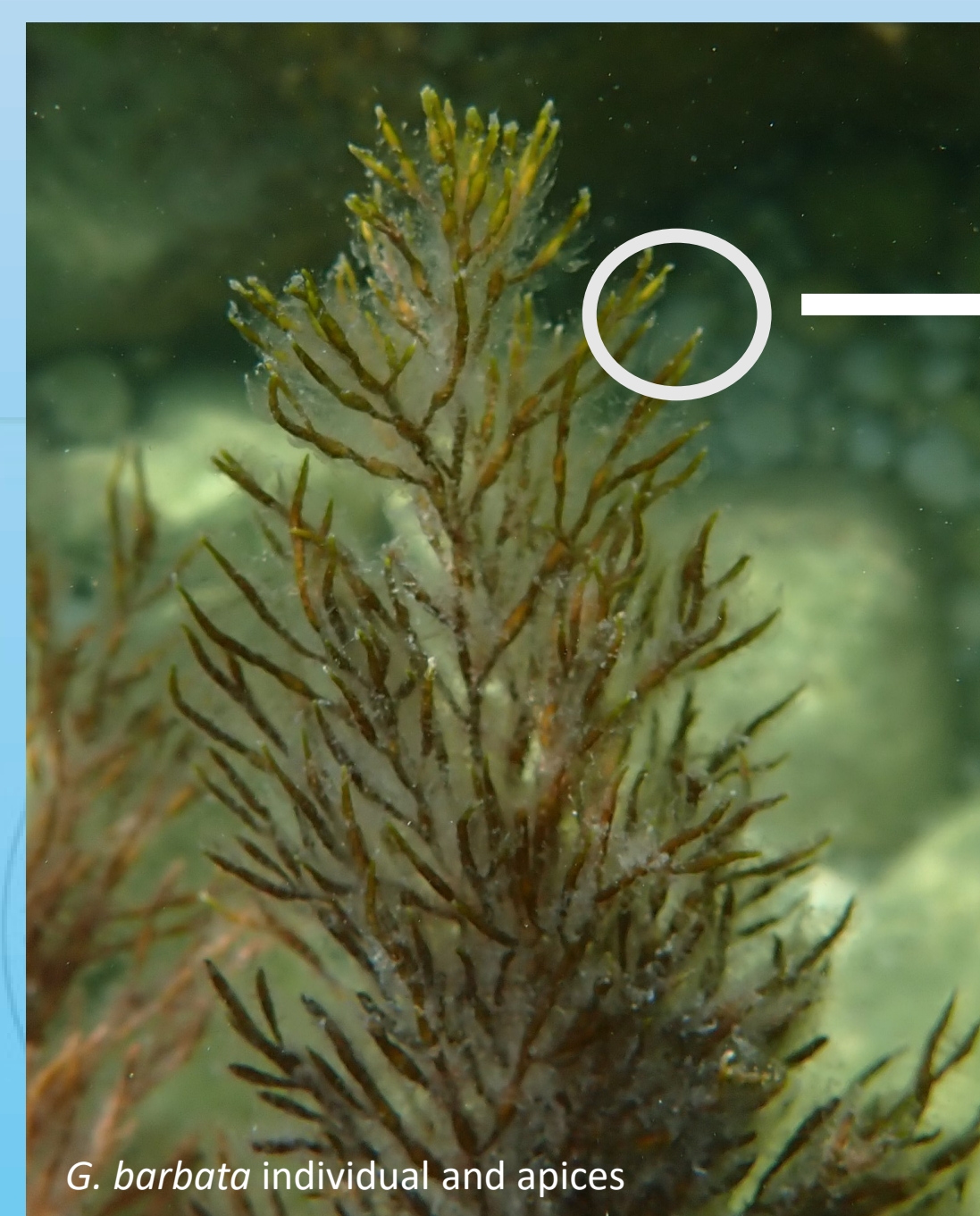
Experimental systems for the upscaling of restoration interventions (macroalgae and seagrass) and date mussel.

Development of experimental systems and technologies for the maintenance and manipulation of species in deep and extreme environments.

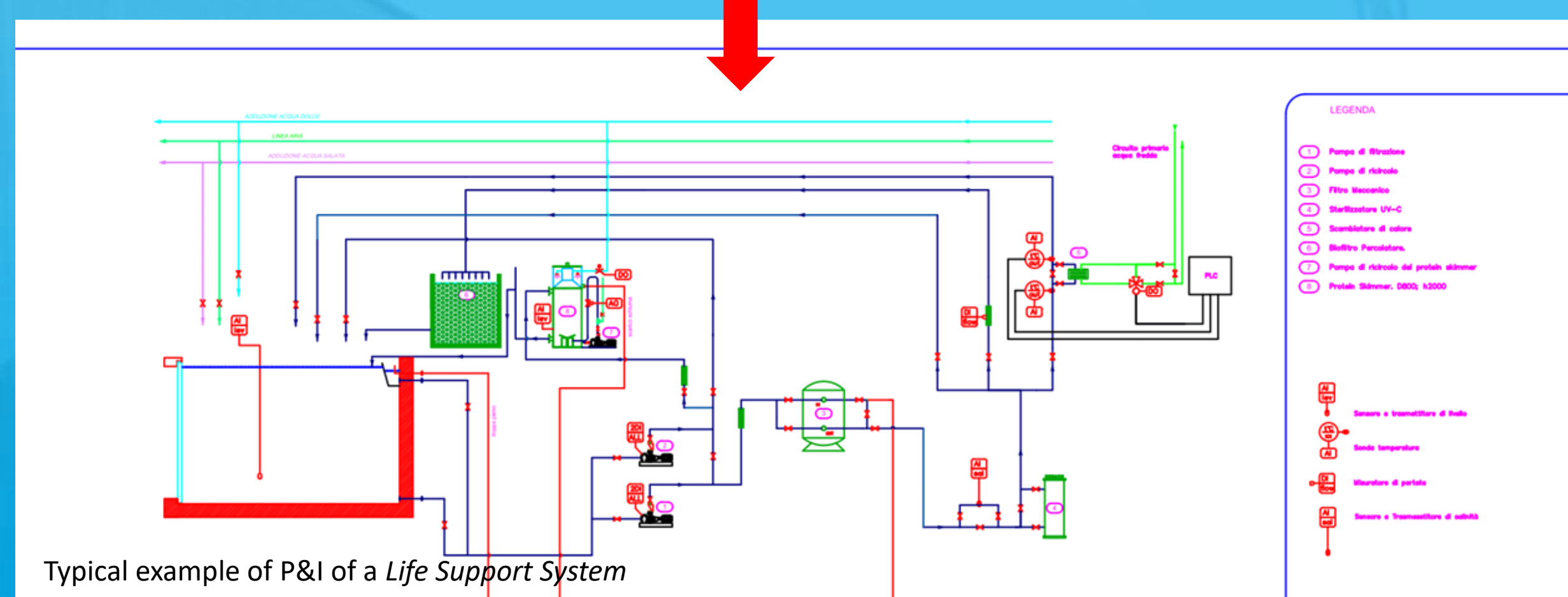
## Upscaling the restoration of *Gongolaria barbata* along the Conero Riviera

In the Mediterranean sea, the canopy-forming species belonging to *Cystoseira sensu lato* play an important role as ecosystem engineer on rocky bottoms. They form forests considered one of the most productive ecosystem. Indeed, the three-dimensional structure of such habitats provides food sources, substrata for settlement and shelter for many smaller algae, invertebrates, and fish.

In the past decades, these forests suffered a serious decline due to the interplaying of several local stressors from anthropogenic sources. Since *Cystoseira* forests follow long-term periodicity, its disappearance from shallow rocky bottoms is considered as indicative of severe environmental degradation. The need to restore the degraded populations arises. Restoration protocols are nowadays available and scientific evidence demonstrated that the restoration is feasible. However, new approaches and technologies to upscale the interventions are needed.



Through preliminary observations we selected a donor site (DS), currently hosting a healthy population of *G. barbata*. We took few fertile apices to avoid impact on the donor population. The fertile apices were transferred to the aquarium facilities to allow the massive production of new juveniles. To guarantee the highest standards in the maintenance of marine organisms in a controlled environment, we will use LSS (*Life Support System*).



In the aquaria, some small nets were put on the surface with the fertile apices inside and on the bottom were put clay tiles on which the zygotes will fall resulting in new recruits. The temperature (about 20°C), photoperiod (15L:9D) and light intensity (125  $\mu\text{mol photons m}^{-2} \text{s}^{-1}$ ) were set to reflect the environmental conditions at sea during the reproductive period of the species.

In the aquaria we will analyze the first stages of the embryos, in terms of density and grow rates. Then after about 1-2 months, we will reintroduce the new recruits to the sea and follow their growth in the field. The tiles will be attached to the substrate in selected sites and complementary actions will be implemented (e.g., anti-grazing cages which will safeguard the recruits from the herbivores pressure). During the monitoring, indicators of success will be selected and tested (e.g., growth, physiological variables).

