SIDESTREAM: SECONDARY BIO-PRODUCTION OF LOW TROPHIC ORGANISMS UTILIZING SIDE STREAMS FROM THE BLUE AND GREEN SECTORS TO PRODUCE NOVEL FEED INGREDIENTS FOR EUROPEAN AQUACULTURE

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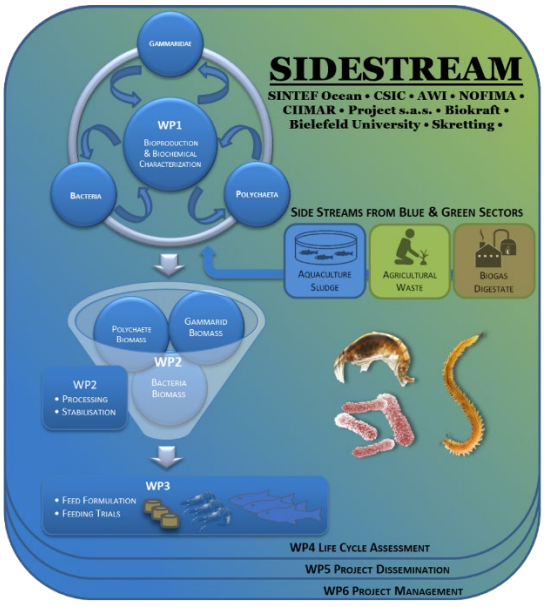
The goal of the BlueBio co-funded SIDESTREAM project was to evaluate new ways of recycling aquaculture and agriculture wastes to save resources and create value.

Aquaculture and agriculture produce vast amounts of wastes. The SIDESTREAM project regards these wastes as 'side streams' and considers them a resource. We investigated to which degree marine organisms such as polychaete worms and gammarid shrimps, and also bacteria can be utilised to recapture nutrients, energy and biochemicals from side streams. Furthermore, we evaluated the suitability of the biomass as a fish and shrimp feed ingredient. Finally, we evaluated the sustainability and economic feasibility of these activities.



All side streams used as feed input for the projects model species were utilized as feeds, in some cases (e.g., liquid phase biogas side streams for bacteria) pre-treatments were necessary. Rearing protocols for the marine polychaete *Hediste diversicolor*, the gammarid shrimp *Gammarus locusta*, and the genetically

modified *Corynebacterium glutamicum* have been established. These protocols have been developed to optimize biomass production, resource utilization and production of high nutritional value fatty acids (gammarids and polychaetes), and astaxanthin (*C. glutamicum*).

During the project we learned how to treat these biomasses to process and stabilize valuable compounds. Further, polychaete, gammarid and bacterial meals were formulated into fish and shrimp feed and tested for their suitability as replacement of either fish meal or fish oil, or as attractants.

Juvenile sea bass (*Dicentrachus labrax*) thrived on diets replacing 10%, 20%, or 40% of the fish meal with polychaete meals. None of the fish fed polychaete meals differed in growth, feed conversion, or protein digestion efficiency from those fed commercial sea bass diets.

Juvenile rainbow trout fed diets containing astaxanthin produced within the project showed less appetite for the diets compared to trout fed diets containing commercially available astaxanthin sources, which was also reflected in reduced growth rates. However, it shall be noted that the astaxanthin produced in the project was used as autoclaved bacterial biomass, not as extracted pigments, which clearly differs from using synthetically produced astaxanthin, and the result is hence to be treated with caution.

LCA analysis revealed that electricity and water usage is a main driver of costs and decreased sustainability when biogas digestate shall be used as feed input. The reason for this is the high ammonia content which needs to be removed from the solid phase. LCC comparing a high-tech and a low-tech scenarrio revealed that scaling effects in the low-tech scenario by far exceeds those in high-tech scarios. LCA on polychaete meals as a fish meal replacer revealed that suggests that the circular approach of rearing polychaete on aquaculture wastes activities may reduce the environmental impact by 23% as opposed to a linear approach.

SIDESTREAM covered several steps along the value chain – from biomass production to the provision of products through conversion and processing. SIDESTREAM enhanced our knowledge on the ability of invertebrates to produce high value compounds. The project lead to novel and refined production techniques and protocols leading to increased production of these compounds under highly controlled conditions.