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Herve Migaud
*President*

Dear EAS members,

It was so good to see so many of you at AE2021 in Madeira last October. We have continued to receive excellent feedback from those who attended on all aspects of the event – the location, the organisation, safety aspects and the general quality of the sessions and overall programme. AE2021 also helped us to 'plug the gap' of 2020, and while our audited financial result for the year remained impacted, we have managed to maintain an acceptable level of reserves on our balance sheet, and we will now hopefully build them up again.

As I said in Funchal, I would like to thank all of you - our individual, institutional and corporate members - for renewing your membership and supporting EAS through a difficult period.

Our planning for AE2022 in Rimini on the Italian Adriatic coast (27-30 September) is now intensifying and we have produced an overview for you in this issue of the magazine. Further updates will be posted on the event website, www.aquaeas.org so please have a look from time to time. Our session convenors are soliciting abstracts for their sessions, with the deadline for oral preferred presentations on May 1. The EAS Board also decided that from now on, the oral slots will be reduced from 20 minutes to 15 minutes to allow more presentations without increasing the number of parallel sessions.

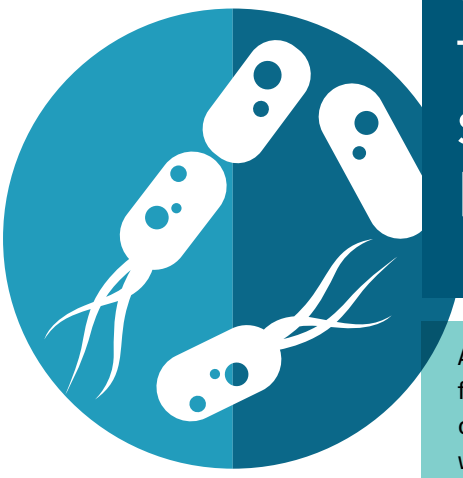
The Board has also approved the location for Aquaculture Europe 2023, that will take place in Vienna from September 18-21, 2023 and for AQUA 2024 (the combined EAS and WAS event) taking place in Stavanger, Norway from June 24-28, 2024. Two great venues to showcase aquaculture, keep the dates in your diaries.

You will also have seen that we have launched our call for candidates to the EAS elections of the 2022-2024 Board of Directors under the Presidency of Bente Torstensen. We have had an exceptionally strong Board over the past four years, but several Board members have decided not to put themselves forward again, so - your chance to play a role in the management and direction of EAS. Deadline is April 22. Feel free to contact us if you want further information.

And as a final word, I am currently in my last few days at the Institute of Aquaculture in Stirling, and will soon embark on a new journey at Mowi Scotland. I will officially hand over the EAS Presidency to Bente in Rimini, but will remain actively involved with EAS until then, and long after as past President. This has been an unusual mandate for me and EAS but we made it through, thanks to the hard work and support of all involved on the Board and AE events, and the loyalty of all EAS members. EAS showed great resilience during an exceptionally challenging period and will continue to thrive.

I hope you enjoy this edition of the magazine in which a range of projects, species and new initiatives are featured.

Herve Migaud, EAS President 2020-2022



# Highlights from gut microbiota survey in farmed fish - European sea bass and gilthead sea bream case studies

AquaIMPACT integrates information on fish breeding and nutrition for improving the competitiveness of European Aquaculture, and complies with consumers' demands for high-quality products with limited environmental impact. To achieve such goals, new fish feeds formulations and additives have been provided to genetically selected fish, being used gut microbiota as a reliable criterion to evaluate the success of AquaIMPACT actions to produce healthier and more nutritious fish. AquaIMPACT contributes in this way to promote the re-circular bioeconomy, the efficient use of resources and zero-waste practices in the aquaculture industry.

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## Nutrition and selective breeding in farmed fish

Fishmeal (FM) and fish oil (FO) are highly nutritious feedstuffs that meet all the dietary nutrient requirements of farmed fish. However, to assure a sustainable development, aquaculture industry has been pushed to reduce its dependence on traditional marine-origin resources, which have been substituted with promising outcomes by a variety of plant-based ingredients, animal-by-products and novel feed ingredients (Hua et al., 2019). At the same time, selective breeding is widely applied to improve the productivity and sustainability of numerous aquatic species, such as European sea bass and gilthead sea bream (Boudry et al., 2021). The benefits of genetic selection usually include the improvement of growth, feed utilization, flesh characteristics and disease outcomes. However, genetically superior fish might also require specific nutritional and feeding strategies at the commercial farm-level to fully exploit their potential.

## Fish microbiota prospects

Intensive selection for productivity traits also has an impact on the microbiota of livestock animals, and new prospects for optimizing fish health and productivity are now emerging from the study of gut microbiota composition in farmed fish. Certainly, research in fish gut microbiota dates to the early half of the 20th century, but interest in this area has grown exponentially with the expansion of the aquaculture industry and the advent of next-generation sequencing (NGS) technologies (Perry et al., 2020). This is exemplified by the Illumina sequencing platform that offers an accurate and rapid identification of microbial communities through the amplification of the 16S ribosomal RNA (16S rRNA), the most widely used technique for the analyses of bacterial communities. However, conventional short-read sequencer platforms cannot yield reads covering the full length of the 16S rRNA gene, which might cause ambiguity in taxonomic classification. This technical constrain can be overcome with the appearance of third-generation sequencing (TGS) platforms that are able of producing long sequences with no

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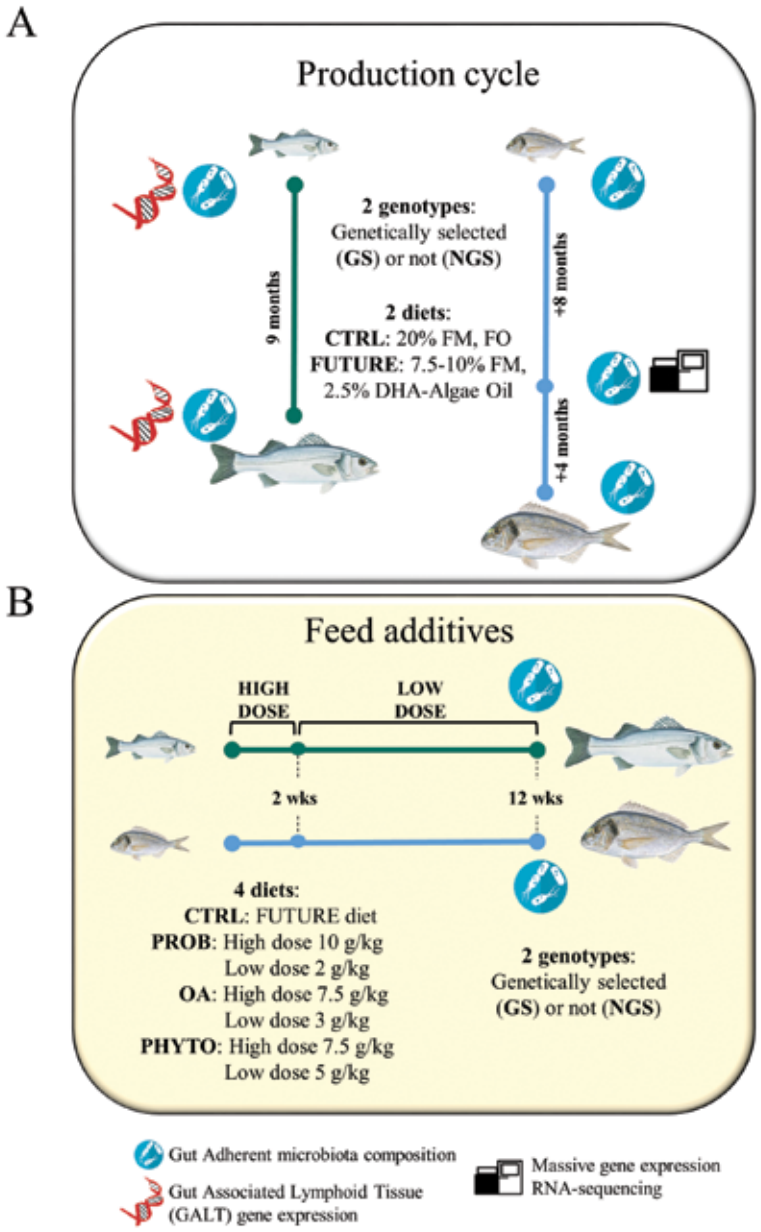


**Figure 1: AquaIMPACT** experimental setup.

theoretical read length limit. A prime example is the Oxford Nanopore MinION Technology which is able to produce low cost sequencing data in an immediacy context unlike other TGS systems (PacBio sequencing). Nevertheless, the accuracy of MinION is lower than other platforms, and its reliable use as a portable tool for quantitative/qualitative determinations is still under evaluation in aquaculture practice.

## Fish gut microbiota is shaped by intrinsic and environmental factors

Fish gut bacterial communities are responsible for the synthesis of vitamins, digestive enzymes, and metabolites, being subjected to large fluctuations that reflect the complex dialogue among the host and the transient and resident microbial communities. Indeed, gut microbiota is influenced by several factors that are distinguished in the host or intrinsic factors (e.g. genotype, physiological status, pathobiology) and environmental or extrinsic factors (e.g. environment, lifestyle and diet) on the basis of their capacity to modify the composition and diversity of gut microbiota as well as its function and metabolic activity (Egerton et al., 2018). Recently, the modulatory effect of diet on intestinal microbiota has been extensively documented in gilthead sea bream (Piazzon et al., 2017; Naya-Català et al., 2021b; Piazzon et al., 2022) and European sea bass (Torrecillas et al., 2017; Rimoldi et al., 2020; Moroni et al., 2021). The same cannot be said for the host genome, whose influence upon the composition and activity of gut microbiota is still scarcely investigated in farmed fish. However, in a recent gilthead sea bream study, Piazzon et al. (2020) stated that the host genetic background has a major impact on gut microbiota, showing that families selected for fast growth have a more flexible microbiota capable of exerting a wider metabolic response to cope with the dietary changes with less microbial community changes. Such assumption was made from the inferred metagenome analyses, which was corroborated by a metatranscriptomic approach that also disclosed a transcriptionally active fungal population particularly in fish fed plant-enriched diets (unpublished results). The **AquaIMPACT** project aims to go further in these genetic- and nutritionally-mediated effects upon gut microbiota, using different genetic stocks of European sea bass and gilthead sea bream growth out in the same location (experimental facilities of IU-ECOAQUA), and fed experimental Skretting diets with/without additives (INVES Technologies). Microbiota analyses were made by IATS-CSIC (gilthead sea bream) and Insubria University (European sea bass).

## AquaIMPACT experimental setup

In a first set of trials, the evolution of gut microbiota and its interaction with the host genome were assessed during the production cycle of European sea bass and gilthead sea bream (**Figure 1A**). In both cases, fish genetically (GS) and non-genetically (NGS) selected for growth were fed for 9-12 months with either CTRL or FUTURE diets at the ECOAQUA experimental facilities. The FUTURE diet was an alternative feed formulation completely devoid of FO and with low inclusion levels of FM, supplemented with DHA algae oil. At initial and final sampling points, juveniles of European sea bass were taken for the characterization of the autochthonous bacteria community by high-throughput sequencing of certain hypervariable regions of 16S rRNA gene (Illumina MiSeq™ platform), and changes in bacteria composition were associated with the changing expression level of Gut Associated Lymphoid Tissue (GALT) genes. Likewise, initial (Nov-19), intermediate (Jul-20; t1) and final (Nov-20; t2) sampling points

were established to assess the dynamics of microbiota composition across the production cycle of gilthead sea bream. Additionally, attention was focus on the intermediate sampling point for correlation analyses of microbiota abundance and host transcriptomic profiling using massive gene expression techniques (RNA-seq).

In a second set of trials, the capacity of functional feeds to modify the composition of gut microbiota was evaluated in GS and NGS fish (**Figure 1B**). The basal diet (CTRL, no feed additives) was the formerly described FUTURE diet (7.5-10% FM with poultry by-products, plant ingredients and 2.5% DHA-algae oil). Experimental diets were oil-coated with the additives: organic acids (OA), *Bacillus*-species probiotics (PROB), or natural plant extracts (PHYTO). Fish were fed to visual satiety at the ECOAQUA facilities with the CTRL diet during two weeks. After this adaptation period, the different supplemented diets were used with a high additive dose (7.5-10 g/kg) during 2 weeks, decreasing thereafter to 2-5 g/kg until the end of the trial (12 weeks). At this end point, randomly selected fish were sampled for the survey of adherent/autochthonous microbiota.

## Gut microbiota is convergent at phylum level with an enhanced homogeneity in genetically selected fish

Regardless of fish species differences in growth, physiological and behavioral traits, most gut microbiota studies disclosed a similar gut microbiota composition at a high taxonomic level. **AquaIMPACT** reinforced this notion in European sea bass and gilthead sea bream (**Figure 2A**). Certainly, during early life stages (production cycle), Proteobacteria was the predominant phylum (~78%) in both species, followed by Firmicutes (13-14.5%), Actinobacteriota (2.4-4%), and Bacteroidota (0.8-1.2%). These shared phyla have been previously described as the most abundant phyla in marine fish gut, but some species-specific phyla were also disclosed for both gilthead sea bream (Fusobacteriota, 2.5%) and European sea bass (Spirochaetota, 4%). Since the same phyla were also found with a relatively high abundance at the end of trials, these findings contribute to highlight the intra- and inter-species

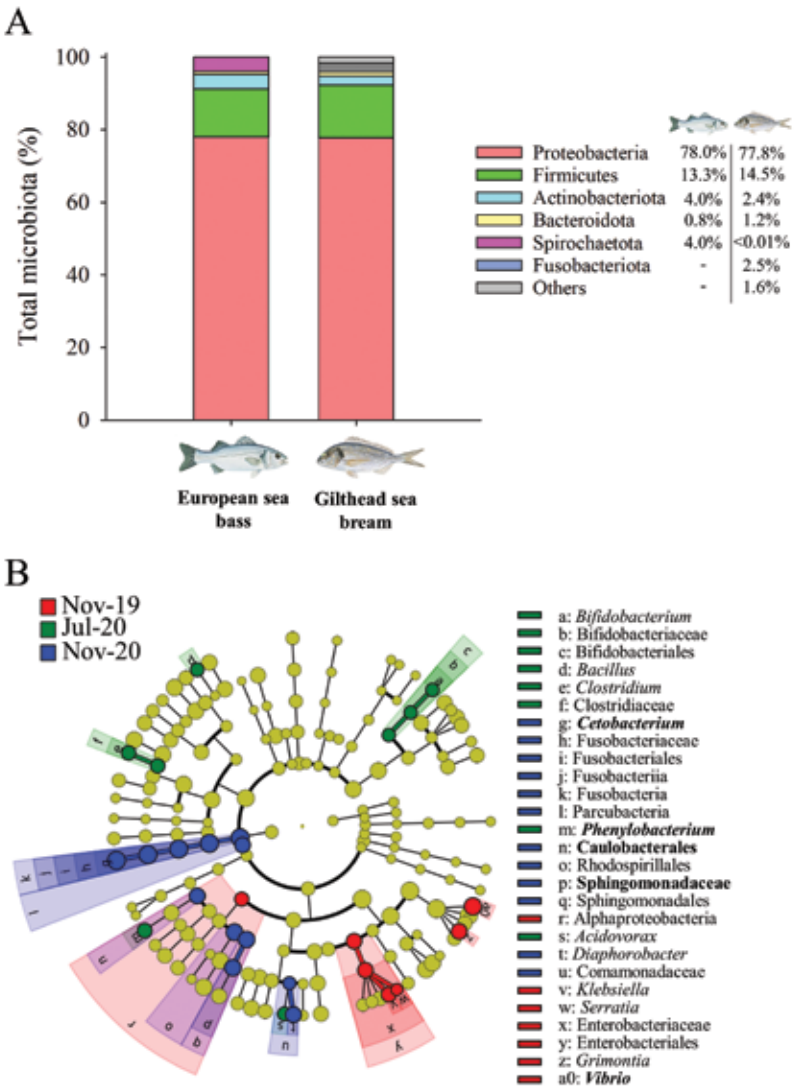


**Figure 2. (A)** Barplot representing the predominant phyla of gilthead sea bream and European sea bass at the beginning of the production cycle in the experimental facilities of IU-ECOAQUA. **(B)** LefSE analysis output cladogram showing the predominant OTUs associated to each one of the sampling times covering the production cycle of gilthead sea bream (red: Nov-19, initial sampling; green: Jul-20, intermediate sampling; blue: Nov-20, final sampling). Bold letters indicate bacteria present at all sampling times at a relatively high abundance (>1%).

stability of the microbiota structure at the phylum level even when husbandry conditions are almost identical.

Considering the microbiota of gilthead sea bream along the production cycle in more detail, a total of 228 OTUs were found in at least one individual of all groups and sampling times. This finding contributes to define the core microbiota of this farmed fish with a subset of 25 OTUs that represented at least the 35% of the gut bacteria population at a given time through the **AquaIMPACT** production cycle. In this core fraction, we found OTUs assigned to Caulobacteraceae family and *Corynebacterium*, *Arthrobacter*, *Propionibacterium*, *Staphylococcus*, *Streptococcus*, *Cetobacterium*, *Phenylobacterium*, *Reyranella*, *Sphingomonas*, *Ralstonia*, *Aquabacterium*, *Acinetobacter*, *Pseudomonas*, *Photobacterium*, *Vibrio*, and *Brevinema* genera. Conversely, when discriminant analyses (PLS-DA) were performed, a total of 140 OTUs with discriminant value for age and season were evidenced. This fraction included OTUs assigned to *Klebsiella*, *Serratia*, *Grimontia*, and *Vibrio* genera that were predominant at the beginning of trial. The genera *Bacillus*, *Clostridium*, *Phenylobacterium*, and *Acidivorax* were associated to the intermediate sampling point. By last, the higher abundance of the Sphingomonadales and Rhodospirillales orders and *Diaphorobacter* and *Cetobacterium* genera was significant at the end of trial (**Figure 2B**). Since most of these OTUs

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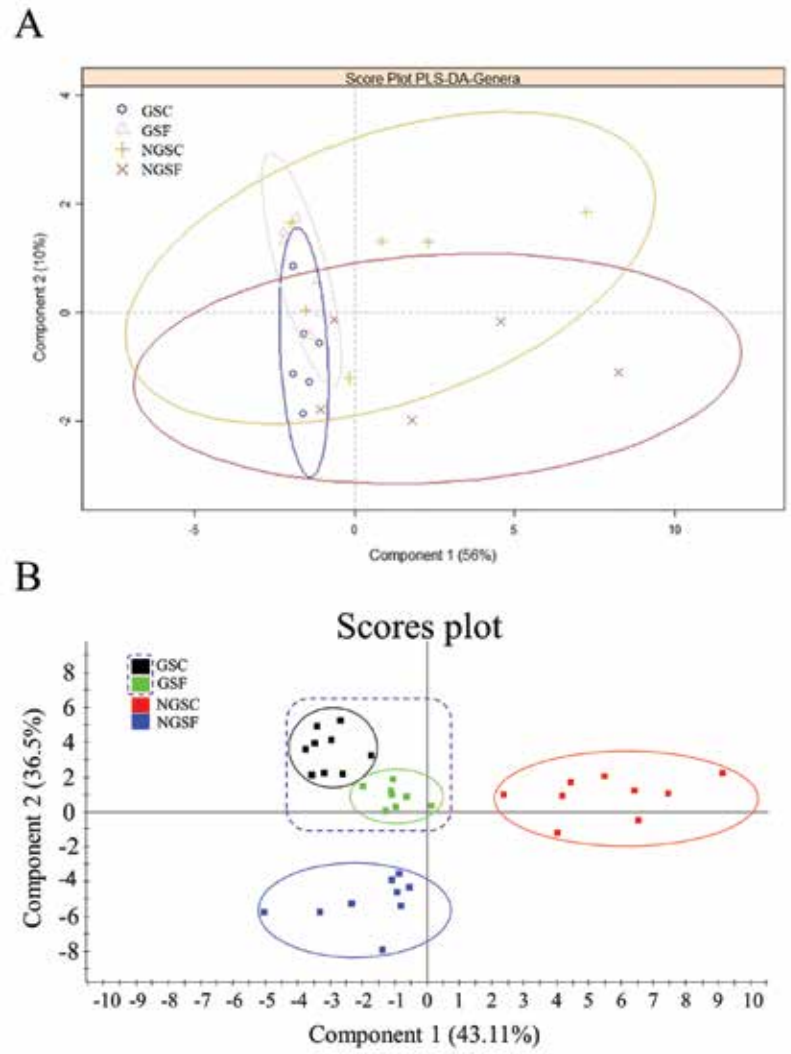


**Figure 3.** PLS-DA score plots disclosing the nutrition and genetic interactions upon the gut microbiota of (A) European sea bass (final sampling) and (B) gilthead sea bream (intermediate sampling).

also shaped microbiota changes over the European sea bass production cycle (two sampling points), they emerge as putative targets to fully understand the host and gut microbiota interactions along different age-seasonal growth stages.

Fish species similarities were also evident when analyzing the individual variability of microbiota composition in response to a given genetic and nutritional background. Thus, at the end of the European sea bass trial, PLS-DA showed a great deal of overlap between groups, though differences between strains were found in both multivariate dispersion and centroid location (**Figure 3A**). Similar results were found in gilthead sea bream (specially at the intermediate sampling point), but in in this case a more pronounced separation between GS and NGS was found for fish fed CTRL and FUTURE **AquaIMPACT** diets. In any case, GS fish of both species constituted a less disperse group than NGS fish (**Figure 3B**). These findings supported what Piazzon et al. (2020) previously claimed in gilthead sea bream, i.e., *gut microbiota of fish selected for growth become at the same time more structurally stable and more functionally plastic against changes in diet composition*. In other words, the gut microbiota of NGS individuals did not functionally respond to dietary changes, whereas GS fish modulated the activity of gut microbiota when dealing with diet changes. This also results in a reduced gut microbiota entropy (individual variability), which is viewed as an enhanced availability to cope with changes in diet composition.

## Functional feeds regulate gut microbiota in a fish-species specific manner

The use of feed additives has expanded rapidly as an alternative for antibiotics and chemotherapeutics, with also the capacity to modulate changes in the composition of gut microbiota. This has also been disclosed by **AquaIMPACT**, which highlights how the microbiota of GS and NGS fish can be differentially regulated in European sea bass and gilthead sea bream by three oil-coated feed additives: organic acids (OA), *Bacillus*-species probiotics (PROB), or natural plant extracts (PHYTO). A summary of the main effects of feed additives in a fish-species comparative manner is shown in **Figure 4.**

In European sea bass, discriminant analysis did not show a clear separation among CTRL and fish fed additives regardless of the genetic background, though some effects on the relative abundance of specific taxa were disclosed. Organic acid dietary supplementation increased the relative amount of *Streptococcus* regardless of the genetic background, while bacteria belonging to *Photobacterium* genus were preferentially associated to NGS fish. Regarding the PHYTO supplementation, Lactobacillales order and Weeksellaceae family members resulted in a higher abundance in NGS-PHYTO fish. This was in line with previous studies assessing the effect of dietary supplementation with galactomannan oligosaccharides and phytogenics on gut microbiota of European sea bass fed low FM/FO diets, in which a reduction of potentially pathogenic taxa with an increase in Lactobacillales was stated (Rimoldi et al., 2020). Similarly, the gut microbiota of GS-PHY and GS-PROB fish experimented an increase of *Enterovibrio* genus, and a decrease of *Novosphingobium* and *Sphingobium* genera. Lastly, dietary supplementation with PROB exhibited a bactericidal effect against *Pseudomonas* and *Acinetobacter* genera with a reduced abundance in both GS and NGS fish. The antagonistic activity of *Bacillus* against *Acinetobacter sp.* has already been demonstrated *in vitro* (Kavitha et al., 2018), having the *Bacillus*-based probiotics the capacity to regulate the European sea bass microbiota despite of a lack of colonization of the host's intestinal mucosa (Moroni et al., 2021).

In gilthead sea bream, the **AquaIMPACT** trial of feed additives confirmed and extended the notion that the individual variability in gut microbiota composition is markedly reduced in GS fish. This applied to fish fed CTRL, PROB and OA diets, but not to PHYTO-GS fish. This nutritional and genetically-guided group differentiation was driven by a total of 104 diet-specific OTUs, according to which: i) the PHYTO

additive increased individual variability of NGS fish, failing to reshape the gut microbiota in both GS and NGS fish, ii) the OA reshaped the gut microbiota in NGS with a decrease of *Photobacterium damselae* sp. and an increase of *Paracoccus* and *Acinetobacter* genera, and iii) the PROB diet modified the gut microbiota in both GS and NGS fish with a higher abundance of *Kocuria* (GS) and *P. damselae* (NGS) that was concurrent with a higher abundance of *Bacillus* genus, which would reflect the establishment of the probiotic bacteria in the mucosal adherent surface favoring long-term health promoting probiotic effects.

## Prospective survey linking taxa abundance with host transcriptomics

To fully understand the relation among the host genome, the nutritional status and the selective breeding, further research will be focused on the survey of the connections between gut microbes and the host metabolic responses at both local and systemic level. To fulfill this purpose, the integration of multi-omics techniques might have a key role. In **AquaIMPACT** trials, a prime example of this is the positive correlation between the abundance of *Paracoccus* genera and the expression level of a well-known pro-inflammatory marker (*il-1β)* in European sea bass, as previously stated in gilthead sea bream for the intestinal *P. yeei* abundance and the expression of *tnf-α* (another pro-inflammatory gene) in head-kidney (Naya-Català et al., 2021a). In **AquaIMPACT**, this type of associations were further exemplified in gilthead sea bream by significant correlations linking intestinal microbiota with a number of host physiological process driven by massive changes in gene expression profiling (RNA-seq), mostly related with immune response, lipid metabolism, collagen metabolism, and the extracellular matrix organization.

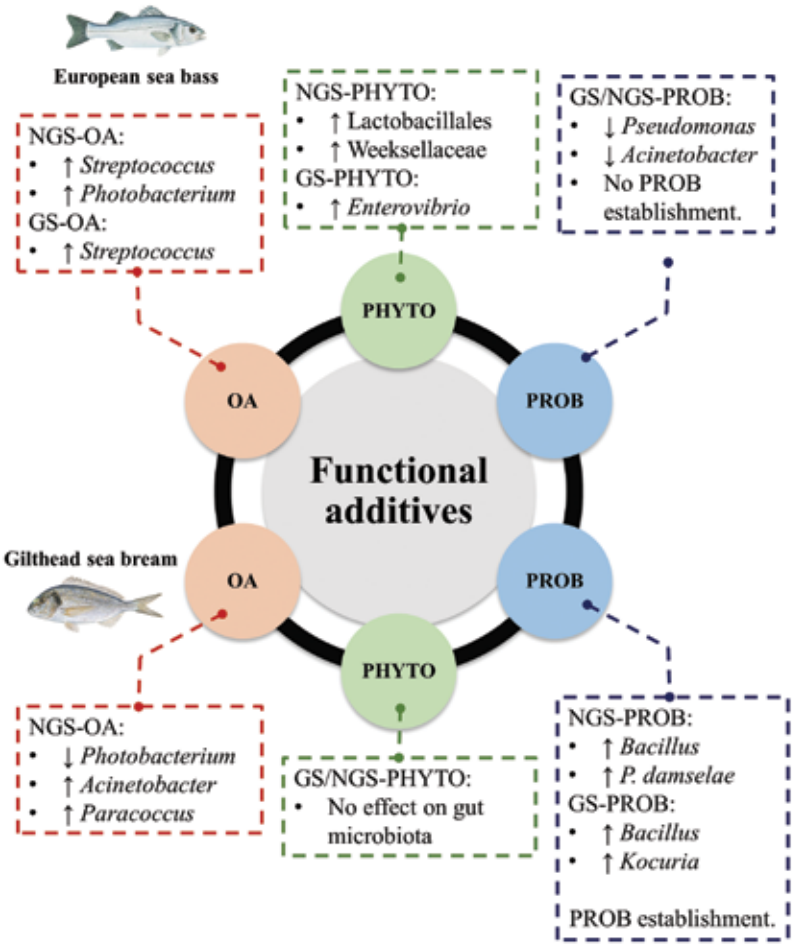


**Figure 4.** Main effects of functional organic acids (OA), natural plant extracts (PHYTO), or *Bacillus*-species probiotics (PROB) supplementation on the gut microbiota composition of genetically selected (GS) and not genetically selected (NGS) European sea bass, and gilthead sea bream.

## MAIN HIGHLIGHTS

- Gilthead sea bream and European sea bass share a similar gut microbiota composition at the phylum level, where Proteobacteria, Firmicutes, Actinobacteriota, and Bacteroidota are predominant.
- Gut microbial composition of both species is influenced by the genetic background.
- In both species, the gut microbiota of genetically selected fish shares a low individual variability, which can be understood as an enhanced capacity to cope with changes in the environment and diet composition.
- The effect of functional additives on gut microbial profiling is fish species-specific and dependent on additive and genetic background.
- *Bacillus*-based probiotics are not equally established in the intestinal mucosa of European sea bass and gilthead sea bream.

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# Applying Ozone for Sustainable and Effective Aquaculture Treatment

*As part of its business model for export from Europe to the US market, Ideal Fish reduces its aquaculture carbon footprint in Branzino (Dicentrarchus labrax) production by using a sustainable RAS system. In this article, Diane White, Industrial Disinfection Sales Manager of Evoqua, presents an overview of ozone treatment in aquaculture.*

Recirculating Aquaculture Systems (RAS) have a wealth of advantages when compared to pond or cage-based aquaculture. They have the potential to reduce total water usage, engender higher levels of production, all while creating lower effluent volumes and lower environmental impact.

But as stock densities rise and water reuse increases, waste can accumulate, making environmental control more difficult. In order to keep RAS systems effective, aquaculture requires mechanisms to remove particulate and dissolve organic waste.

Ozone is now being widely used as a critical component to destroy pathogens in both supply and effluent water, with benefits of ease of application and use, and low environmental impact.

## Harnessing the instability of ozone for water treatment

Ozone is a highly oxidizing gas that can destroy impurities such as organics, pesticides and nitrites, while reducing discoloration and tannins. Applying ozone as part of a total system can contribute to fish health throughout the farming process and can also help to maximize yield.

Ozone (O3) is formed when an oxygen molecule (O2) is reacted to bond with a third oxygen atom. Because this third atom is only loosely bound to the molecule, ozone is highly unstable. This instability is the property that makes ozone an excellent oxidizing agent - and ideal for use in water treatment. Ozone has many direct applications that address common issues affecting aquaculture health and yield. Water quality levels deteriorate with high levels of dissolved organic compounds (DOC) due to fish activity.

Ozone removes these dissolved organics by oxidation, breaking them down into products that are more readily nitrified in the biofilter; including precipitation, which enables removal of waste particles by conventional filtration or sedimentation.

Ozone also removes nitrite - which can be toxic to fish at high levels - via direct oxidation and through an overall reduction of organic loading, which improves biofiltration efficiency and nitrification.

The micro flocculation of fine solids created by ozone is also of importance in this application, as it will improve the farm's particulate removal efficiency via their filtration process. Ozone will also change the characteristics of dissolved organic compounds (DOC) by oxidation and precipitation, making it easier to remove DOC by biofiltration and sedimentation.

Ozone can effectively inactivate a range of bacterial, viral, fungal and protozoan fish pathogens*. Ozone also causes solids to form clumps (micro flocculation), which enables the removal of fine and colloidal solids by foam-fractionation, filtration, and sedimentation.

## Applying ozone in aquaculture

When applied in water treatment, the amount of ozone required depends on the background organic load of

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the water. The effectiveness of the treatment also varies on the concentration, length of ozone exposure, pathogen loads, and levels of organic matter. If there are high levels of organic matter present, oxidizing this organic matter can make it difficult to maintain enough residual ozone for effective disinfection.

When applied in pure water, residual concentrations of 0.01-0.1 ppm ozone can be effective for reducing bacterial loads over periods of just 15 seconds. However, in water with changeable organic loads, the concentration of residual ozone or the contact time has to be increased in order to produce effective treatment. For example, natural waters require residual concentrations of between 0.1-0.2 ppm ozone and contact times of 1-5 minutes for disinfection.

For treatment after the oxidation of organic components, aquaculture applications require a concentration of residual ozone between 0.2-0.4 ppm, applied for between 1-5 minutes. The changing profile and organic load in aquaculture systems means that ozone application needs to be variable and reactive.

## A mission-critical treatment for Ideal Fish's recirculating aquaculture system


With so many theoretical applications and variables to consider with ozone treatment in the aquaculture industry, it's important to examine the practical implications in a real-world dynamic aquaculture environment. To understand the effects of the use of ozone, Evoqua looked at a case study from Ideal Fish.

Ideal Fish was formed in 2013 and is proud to be the only provider of Branzino for the US market. Ideal's goal is to provide American consumers with fully sustainable, transparent, high-quality fish. As part of their business, Ideal Fish eradicates the carbon footprint of importing Branzino from Europe while supplying the US market with a prized high quality niche product.

With a clear sustainability mission, Ideal Fish needed to implement an efficient and economical disinfection solution. Their goal was to improve water purity and to create a more biologically efficient environment for growing a live product, free from hormones, antibiotics, or chemicals.

Ideal Fish operates a recirculating aquaculture system (RAS) in which water is reused. They implement a highly technological mechanical set of procedures to filter and clean the water to create a more sustainable farming process, and using less water, energy and space than would normally be required by such a system.

The team at Ideal Fish reached out to the disinfection aquaculture experts at Evoqua to inquire as to the most efficient and economical disinfection solution to help remove aquaculture pollution and create a better, more biologically efficient system for the fish to grow in.


Evoqua's aquaculture treatment team provided one Pacific Ozone™ MNG Ozone Generator to meet the needs of Ideal Fish. The generator delivers powerful, ultra-flexible and precision-controllable large industrial ozone production systems from 140g/h (5lbs/day) to 1.4kg/hr (75lbs/day).

The ozone generator has programmable operating modes that can be adjusted in 70g/h increments. This provides full resolution control and automatically adjusting feed gas flow rates for full efficiency and ozone production optimization.

The water quality, bacterial load management and fish health of Ideal Fish's system are all dependent on this ozone generation and its delivery. To ensure maximum efficiency and longevity of the system, the materials used to generate ozone must be resistant or inert to ozone. Reactive materials can cause erosion that leads to dangerous and costly leakages. The generation of ozone in systems with substandard materials is also less efficient as ozone is lost as the materials of the reactor are oxidized.

Materials including some plastics, such as polyvinyl chloride (PVC) or galvanized steel are not recommended for long-term applications due to these risks of leakages and the need for maintenance. The ozone generation system implemented by Ideal Fish uses a Stainless-Steel single and configured enclosure for stable and consistent generation.

## Results and effects of ozone treatment in a RAS system

After some months of use, the team at Ideal Fish saw an increase in water clarity and fish performance. This enabled them to increase the growth and production of their aquaculture, alongside controlled and precise application of ozone.

As the product grows and an increase in ozone is needed, the adaptability of the generator allowed Ideal Fish to adjust the delivery of ozone to their system. With separate SEP systems, operational parameters can be varied for either individual or group tanks. This means Ideal Fish now have the capabilities to ramp up - or down - ozone percentage requirements. Operational alarms allow Ideal Fish to reliably adapt to the daily changing parameters of growing a live product.

This precision has enabled more focused and concise production control from the unit, increasing the re-circulation rate, in turn making operations more efficient and more environmentally sustainable.

*Evoqua Ozone Generation systems undergo factory acceptance testing to ensure they can produce the desired ozone concentration, based on operational parameters outline in the Operating Manual. System performance of microorganism inactivation depends on the CT value, pH, and temperature of the water. Performance limitations depend on feed conditions, overall installed system design, and operation and maintenance processes; please refer to Operations Manuals for more information.

# The effects of offshore wind farms on fisheries and aquaculture

A report lead by Wageningen Marine Research (including Wageningen Economic Research) in consortium with other European partners has published an overview of the effects of offshore wind farms on fisheries and aquaculture for the European Commission European Climate, Infrastructure and Environment Executive Agency.

Its overall objective is to provide an overview of the state of knowledge on the existing and potential future effects of offshore wind farms (OWFs) on fisheries and aquaculture. A literature review on several aspects (ecology, management, legislation, socio-economics, stakeholders and governance) is executed, and complemented by stakeholder interviews and two case studies.

Its key findings and recommendations (from the executive summary of the report) are presented here.

## Ecology

Findings show that the installation and presence of offshore wind structures may lead to a diverse set of changes on the seafloor ecosystem. The type of effects is also related to the implementation stage of the OWF (construction, operation or decommissioning). Effects rank from low to medium or mixed.

During construction, the marine ecosystem is temporally negatively disturbed through sediment displacement (altering the biodiversity) and high impulsive sounds from piling. During the operational phase, introduced structures and/or turbine foundations change the local habitat characteristics, leading to mixed effects.

Some can be considered as positive, as they provide a surface for colonization by fouling species and by attracting various fish (pelagic and demersal) and crustacean species (e.g. crabs, lobster) (artificial reef effect). This changed the trophic interactions between species, with species profiting from the increased food availability or organic enrichment, also due to changes in hydrodynamics within OWFs. This altered biodiversity and species occurrence can lead to changes in ecosystem functions and processes, which are not yet well studied and are typically not addressed by environmental impact assessments (EIAs). Other effects are perceived more negatively, as the stepping-stone effect for alien species, the effects caused by electromagnetic fields and operational sound.

Most OWFs are 'de facto' closed areas for fisheries. As such, an OWF area can be seen as a passive refuge and recovery area for long-living benthic species and fish, potentially resulting in higher densities and larger animals. Nevertheless, in practice, the effect seems currently modest in the short run. Therefore, in relation to fisheries, it is unknown what the observed changes (e.g. 'spill over' effect) mean at population level or wider regional scale for fish stocks.

The effects of decommissioning the OWF structures on ecology (e.g. some ecological benefits shall change), engineering possibilities (e.g. not increasing the OWF footprint in an area) and socio-economic aspects (e.g. OWF area back as fishing ground?) need to be collected.

Recommendations:

- Ecological research needs to be further oriented towards ecosystem-based approaches to better put into context if OWFs are benefiting ecosystems for fisheries and aquaculture.
- The ecological effects are documented, but the degree to which OWF development leads to changes in biodiversity, species composition, spillover effects and habitat characteristics in the short, medium and long term have to be defined on wider scale (i.e. marine resource management scale).

## Management

There is no general approach on management strategies for fishery and aquaculture in OWFs, as it is regulated case-by-case. The OWF development process is part of the obligatory maritime spatial planning (MSP) process for EU member states. The literature review and interviews conducted here show that the concerns of the fishery sector are often not fully considered in designing the OWFs areas. Some OWFs have set up compensation mechanisms for displaced fisheries; others have not. There are several hurdles that make co-

location with fisheries difficult, such as safety risks (collision, cable damage) or the distance between turbines (to be larger to allow fishing operations).

Therefore, the MSP management process needs to take into account these challenges to ensure co-existence between fisheries and OWFs. Consultation (from early stage and on continuous basis) can be regarded as a mitigation strategy to achieve this.

For offshore aquaculture, which has a clear co-location potential, too few experimental studies testing its technical and economic feasibility are conducted and proving that there are many hurdles. Besides, the lack of clear licensing procedures and regulations are slowing down the development of offshore aquaculture in OWFs.

Recommendations:

- Describe good practices of management with respect to coexistence, colocation and cooperation of aquaculture and fisheries and describe the net benefit for both sectors for good management practices on the business model, livelihoods, social well-being.
- Analyze the short and medium term losses in monetary units for the fishing sector due to OWF development, while considering the resilience of thesector in the short and medium term by taking into account their potential to relocate effort or change occupation. This should give insights in possible compensation.
- Clarify the management and legal framework for offshore aquaculture activities by analyzing the different ways the multi-use process can be stimulated (e.g. incentives) and be better embedded in the member states legislations and procedures (e.g. licence process).

## Legal

The right of Member States to regulate fisheries and aquaculture activities in and around OWFs derives from the United Nations Convention on the Law of the Sea (UNCLOS), which confers upon them a right to claim a 12 nautical mile (nm) territorial sea (full sovereignty) and a 200 nm Exclusive Economic Zone (sovereign rights).

Consequently, each Member State is free to adopt its own specific legislation on safety zones around OWFs. There is no common approach to legislation on safety around OWFs. In some Member States, the legislation provides for the creation of 500 m safety zones around OWFs in which all navigation is prohibited. Elsewhere the legislation permits navigation through OWFs but prohibits fishing either altogether or using active gear. In some Member States, safety zones are applied only during construction, maintenance and removal.

Recommendation:

- Create an overview of national legislations determining the operability (possibilities and restrictions) of fishing and aquaculture in and around OWFs, and identify the possible modifications to these legislations for fishery and aquaculture stakeholders to operate within OWFs.

## Socio-economic

The major socio-economic effects for fisheries are the loss of fishing grounds (economic value, but also emotional value), leading to effects on catch volume, gear conflicts (e.g. bottom trawl gears cannot operated within OWFs, restrictions in anchoring passive fishing equipment [Pots, nets] within OWFs) and changes in travel time from harbour to fishing grounds. Fishermen tend to compensate for these through fisheries displacement (moving to other areas or fishing around the OWF edge) and switching to other gear types (e.g. mobile gear to crab or lobster potting). Nevertheless, this is associated with several issues, e.g. increased competition, safety implications (e.g. collision, cable damage), reduced flexibility and economic viability.

It should be noted that there is no study that has provided complete quantitative data on the economic effects, especially those covering the full value chain (fishing, processing, transport, marketing). Therefore, positive or negative claims about the eventual socio-economic effects were not validated in this study.

Similarly, socio-economic effects on offshore aquaculture were not identified, mainly because aquaculture in OWFs is still in its infancy and there were no real business cases or spatial conflicts that could be identified. Nevertheless, aquaculture within OWFs is identified in literature as the major co-use concept, offering possibly several advantages (creation of jobs directly and indirectly, new skilled labour, specialized suppliers, education programs, innovation jobs) and therefore enhancing and transforming local communities.

Recommendation:

- Develop the socio-economic balance for the fishery and offshore aquaculture sector in relation to restrictions and/or opportunities caused by OWFs to have a better view on possible compensation needs for fisheries and wins for offshore aquaculture.

## Stakeholders

Stakeholders provided different views (often polarized by sector and areas) on the issues under study. These were largely dependent on the background of the stakeholder and their direct interactions with OWFs and collaborative opportunities with other stakeholders.

Best practices in stakeholder governance were identified as early engagement in discussions and planning of OWFs, alongside support for active enforcement of multi-use in future marine spatial planning.

Recommendation:

- Early engagement in discussions and planning, on a continuous basis and by taking into account the fishery and aquaculture needs from the start of the OWF design is essential to create beneficial conditions for future multiuse and co-location of fishery and offshore aquaculture activities with OWFs.

Van Hoey, G., Bastardie, F., Birchenough, S., De Backer, A., Gill, A., de Koning, S., Hodgson, S., Mangi Chai, S., Steenbergen, J., Termeer, E., van den Burg, S., Hintzen, N., Overview of the effects of offshore wind farms on fisheries and aquaculture. Publications Office of the European Union, Luxembourg, 2021, p. 99

https://op.europa.eu/en/publication-detail/-/publication/3f2134f9-b84f-11eb-8aca-01aa75ed71a1

# The AQUA-FAANG project:
## Improving the understanding of the expression of biological traits in fish

**Infectious diseases are one of the main issues in sustainable farmed fish production in Europe, accumulating a yearly economic loss of 1800 million Euros. Infectious diseases are expected to increase even more because of climate change, pressing the need to breed more resilient farmed fish strains. Advanced understanding of the regulation of genes in fish may help us understand and improve important traits such as disease resistance. The EU-funded project AQUA-FAANG will lay the foundation for improved selective breeding to help tackle the main issues in aquaculture production.**

### Mapping information about the genomes

Recent developments in genomics have advanced innovation in European aquaculture. However, the current understanding of genome function remains limited in major farmed fish species. Therefore, the aim is to understand better how the genes of fish are being expressed to influence traits of commercial importance. To achieve this, the genome – the complete set of genetic information found in every cell - will be studied to determine how genes are regulated under different biological conditions. The project's key focus is to address the challenge of aquaculture infectious diseases, like viruses, bacteria, and parasites, a significant threat to sustainable fish farming.

The AQUA-FAANG project will generate high-quality maps of fish genomes, as depicted in figure 1, revealing detailed information on the expression of biological traits. The project focuses on the six most important farmed species in Europe: Turbot, European Seabass, Gilthead Seabream, Atlantic Salmon, Rainbow Trout, and Common Carp, seen in Figure 2.

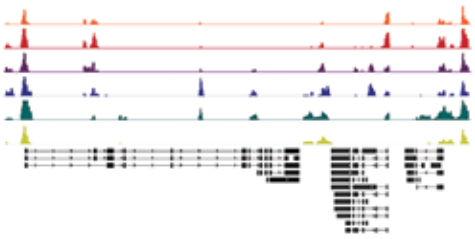

**Figure 1:** Example of a genome map. This map shows the location of genes (in black) and their expression level (colours)

### Standardised protocols enables comparison and collaboration

To understand how the genome is linked to biological traits, it is not sufficient to only sequence the genes. Several methods need to be performed, each providing different types of information on which parts of the genome are activated. By comparing results from these methods, it is possible to understand in more detail how the genome reacts to the environment and how it is linked to a biological trait. Standardised protocols on sampling and sample preparations on the different fishes and organs are developed, and data is collected (available on website: www.aqua-faang.eu). Following this, healthy and immune-activated fish genomes will be annotated. The knowledge obtained by annotation (e.g., gene expression) may be useful to help predict breeding values for disease resistance and other traits. The information on gene expression can be enhanced by comparing the different species and immune states.

The improved understanding of the fish genome serves as a basis for improving fish health and approaches to enhance disease resistance. The project's industrial partners serve as a platform to promote how the results of the AQUA-FAANG project can be implemented. Generated results will be freely disseminated, making them available for other fish species of global importance that are outside the project's scope, such as tilapia and oysters.

*continued on page 16*


**Figure 2:** The six most farmed fish species in Europe

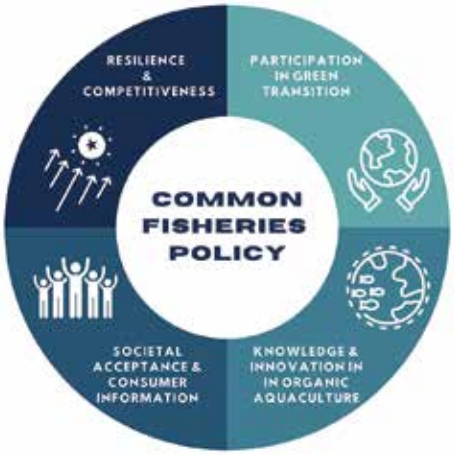


**Figure 3:** Objectives of the common fisheries policy

For example, one of the research groups in the project focuses on improving fish breeding using functional annotation of genomes. A major focus is the problematic disease of farmed European seabass, viral nervous necrosis (VNN). The team has investigated which genes are being expressed as part of its immune response, after being exposed to nodavirus. They determined that host resistance to VNN is moderately heritable, and identified a major locus affecting resistance. The research team will now overlay functional genomic data such as gene expression to help identify the causative gene and underlying mutation.

## AQUA-FAANG impacts

The AQUA-FAANG project will provide beneficial impacts by improving our understanding of the expression of biological traits in fish. The project is part of the EuroFAANG consortium (https://eurofaang.eu/). This joint European research initiative aims to increase the knowledge of the genetic code of farmed animals. By combining contributions from global members and projects, the EuroFAANG consortium will support sustainable and profitable animal production in Europe.

Both the EuroFAANG consortium and the results generated by the AQUA-FAANG project will contribute to attaining the new strategic vision for sustainable aquaculture production and consumption in the European Union and common fisheries policy, seen in Figure 3, by increasing knowledge on disease resistance. This strategic vision aims to use the European aquaculture sector's growth potential and accelerate the green transition. The information on the fish genome revealed during the project could potentially be included in the breeding programs focused on fish health by breeding companies. Aquaculture producers will benefit from healthier fish by reducing disease incidence and the need for pharmaceuticals and antibiotics, thus decreasing the production costs.

Furthermore, improved disease resistance will increase farm profitability, providing opportunities for development in aquaculture, subsequently causing an increase in employment on European farms. By strengthening the European aquaculture sector, consumers will have increased access to healthy, sustainably, and locally farmed fish. Ultimately, improved health and welfare of sustainably and locally farmed fish will be beneficial in the mitigation of societal concerns in aquaculture production.

All of the rich datasets generated by the AQUA-FAANG project are made available through the AQUA-FAANG project page of the FAANG data portal (https://data.faang.org/projects/AQUA-FAANG). AQUA-FAANG data is driving new and improved annotations of these six key farmed fish species. The public release through EMBL's European Bioinformatics Institute's Ensembl genome browser (https://www.ensembl.org/) will provide a powerful resource to drive and accelerate aquaculture research in Europe.


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817923.

# More sustainable and competitive fish
## - a strategy for relaunching Mediterranean fish farming

Tanks full of sea bass at IRTA's premises in Sant Carles de la Ràpita

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*The MedAID project, coordinated by IAMZ-CIHEAM and IRTA, has carried out a global diagnosis of sea bass and gilt-head bream aquaculture in the Mediterranean to identify solutions that will optimise their production and marketing models. Improved zootechnical productivity, food safety and data processing are some of the key elements of this transnational initiative. The sector wants to increase its foothold in the fish market by better adapting to consumer preferences and addressing public perception of aquaculture.*

The Mediterranean fish market is strained between growing demand due to increasing per capita and total consumption, and finite and often overexploited fish stocks. In this catch-22, aquaculture has emerged as a key production alternative for rebalancing supply and demand and ensuring a sustainable source of quality protein. But in Europe, this marine switch-over has become bogged down. EU fish farmers see the sector in countries such as Norway, Tunisia and Egypt on an upward trend, while their own indicators have been stagnating for decades. The situation is conditioned by many factors. On the one hand, aquaculture is suffering technical impediments including low biological yields and shortcomings in the health management of fish farms. On the other, the fact that it is still not widely accepted by society makes it a minority option for fishmongers. Economic volatility, climate uncertainty, and disparities in the legal and governance framework throughout the Mediterranean basin pose even greater challenges for the sector.

To boost the future of this industry, the Mediterranean Aquaculture Integrated Development (MedAID) project was launched in 2017. This four-year project, coordinated by the Mediterranean Agronomic Institute of Zaragoza (IAMZ-CIHEAM) and the Institute of Agrifood Research and Technology (IRTA), and also involving research centres, companies and other stakeholders from 13 European and Mediterranean countries, is aimed at relaunching Mediterranean aquaculture in a more sustainable and competitive manner. The research scope is very broad and includes a study of the productive, environmental, economic and social obstacles throughout the aquaculture value chain, focusing on sea bass and gilt-head bream, the two most widely produced species. "We wanted to approach the problem from a multidisciplinary and holistic perspective; we started by making a global assessment to identify inefficiencies and look for common innovative solutions", explains Dolors Furones, a researcher in the IRTA's Aquaculture programme and the project's scientific coordinator. Last October, MedAID concluded with an event at AE2022 in Madeira, where the toolbox, a digital repository of all the new knowledge obtained, was presented to scientists, producers and stakeholders.

One of the great challenges for Mediterranean fish farming is to optimise resource management in order to reduce costs and, in parallel, mitigate the environmental burden of its activity. "MedAID has looked into how the industry needs to adjust in order to improve its carbon footprint, especially in terms of logistics and feed consumption", explains Furones. Indeed, zootechnical improvements in the feeding and rearing cycle of sea bass and gilt-head bream have been the

focus of a great deal of research effort. Different larval rearing conditions have been tested, as have more sustainable and functional diets that improve performance and make the fish more resilient to pathological and environmental challenges. In addition, one of the most promising avenues is genetic improvement. MedAID, together with the Performfish project, has developed a chip for genomically analysing gilt-head bream and sea bass (MedFish SNP). It can be applied to genetically characterise farmed and wild populations, a very useful information tool for establishing breeding management programmes. The technology has also made it possible to study the heritability of certain traits related to fish quality, such as the proportion of lipids in the muscles.

Animal health is the other major biological variable in fish farm productivity. Aquaculture has tended to shift towards more intensive systems, meaning the animals are more susceptible to infectious diseases. MedAID therefore carried out a risk assessment of the most important pathogens in the Mediterranean, including NNV (nervous necrosis virus), for which a new vaccine has been tested with very encouraging results. Progress has also been made towards more coordinated management of epidemiological knowledge and strategies, and a more systematic evaluation of biosecurity measures.

## Raising awareness and attracting consumers

"Aquaculture has problems beyond the technical field. It's not just about whether the fish grow better or worse, but also the perception of the product itself and its production", says Dolors Furones. The IRTA researcher points out a lack of public knowledge on the added value of fish farming, a practice subject to strict European regulations and, therefore, with health and environmental safety guarantees. "It has a somewhat negative image, because of the way it has been presented and the way the fish farm facilities have been installed along the coasts", she adds. In the face of such prejudice, MedAID has developed a series of practical guides and methods for countering misinformation and making consumers more aware of the farms, strengthening the sector's dialogue with the public.

In addition, MedAID has delved into the field of marketing to find out how to attract more buyers. Based on market research, the consortium has been working on the reconceptualisation of fish products to adapt them to the expectations of different niche buyers. The sector is trying to increase the variety of fish on offer, with new processing and more attractive packaging that better showcases the benefits of the fish in terms of taste and quality.

## Production intelligence

With a view to modernising and streamlining fish farming in the Mediterranean, the project has also focused on data collection to support strategic decision-making. For this reason, the MedAID DashBoard has been created. This software allows the performance of farms to be technically compared and collects key indicators from producers, thus facilitating the identification of potential solutions.

This knowledge, achieved thanks to the cooperation of stakeholders from different backgrounds and disciplines, should give fish farming the impetus it needs to play a more significant role in the food market. "Aquaculture is not the future, it is the present, perhaps still a little muted, but nonetheless necessary to guarantee a supply of healthy, safe, sustainable and local food", concludes Furones.

*The MedAID project is funded by the European Union's Horizon2020 programme, with a budget of 7 million euros and involves the participation of 34 research bodies, companies and international organisations, including the Food and Agriculture Organisation of the United Nations (FAO) and the Mediterranean Agronomic Institute of Zaragoza (CIHEAM).*

european aquaculture society

# BOARD OF DIRECTORS ELECTIONS

We have recently sent out a Call for Candidates for the office of President Elect, Board Member and Student Representative of EAS for the period of 2022-2024.

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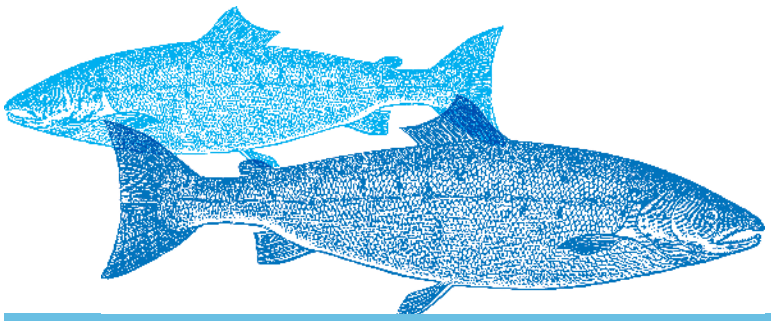
We welcome candidates that are members of EAS and would like to contribute to our further development.
It may be as **President Elect** - becoming President of EAS in 2024; **EAS Student Representative** - giving a student voice to the **EAS Board** (note that candidates must comply with EAS Student membership criteria) or Board member - there are five in total.

**PLEASE SUBMIT YOUR CANDIDATURE BEFORE APRIL 22**

For any enquiries contact EAS at eas@aquaeas.eu



# Can the gut microbiota explain large size differences in farmed salmon?

New hologenomic research, considering the host animal and its associated microbiome as a single intertwined entity, may have answered why large size differences are found in farmed salmon. Preliminary results indicate that part of the answer lies in the power of the gut and its developmental impact on the host fish.

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Photos: Martin Nielsen

How can it be that farmed salmon sharing genetic make-up as well as identical environments and feeding regimes during large parts of the life cycle can vary in size by a factor of ten? What is it exactly that makes some salmon weigh just two kilos while other salmon, identical in age and living conditions, grow up to 10 kilos in size at harvest?

This conundrum is what the FHF-funded HoloFish project[1] set out to solve in 2017. The project has been coordinated by researchers from the Center for Evolutionary Hologenomics at the University of Copenhagen in close collaboration with other researchers from NTNU in Trondheim and Lerøy Seafood Group (Norway). Although not yet concluded, the preliminary results indicate that the gut microbiome and its interplay with the host fish plays a larger role in the size variations than previously assumed.

According to Jaelle Brealey, postdoc and lead analyst on the HoloFish project, and Harald Sveier, Research and Innovation Manager at Lerøy Seafood Group, these unexplained size variations are a fundamental problem that aquaculture has been trying to solve for some time. "The discrepancy is well known in the aquaculture industry," Jaelle says, "salmon from the same genetic background, raised in similar conditions in the same sea pens, still, at harvest time, have vast differences in size - anywhere from two kilogram to ten."

## Beneficial gut bacteria

Rather than focusing on genetics or environmental factors, HoloFish proposes that the gut microbiome of the salmon can help explain the size variations. Analyzing samples from a cohort of 460 farmed salmon from the Bergen area in Norway, all at the age when they would normally be harvested for consumption, HoloFish's preliminary analyses have found a salmon-specific species of the bacteria Mycoplasma as a recurring trait in the guts of the healthiest fish.

"In the microbiome we consistently find Mycoplasma present in the large salmon at very high abundance. In these large salmon, around 80 to 90 percent of the bacteria we find is Mycoplasma. It seems that this bacteria is commensal and quite important for the growth of the healthy salmon," she says.

The HoloFish team in April 2028 taking host tissue and microbiome samples from Atlantic salmon at a farm near Bergen Norway.

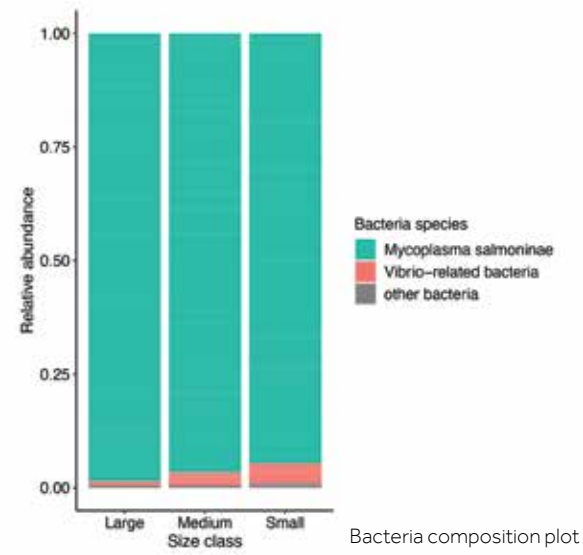
## Less Mycoplasma in smaller fish

The apparent connection between high abundances of Mycoplasma in the host fish's gut and its size can be traced in the smaller fish of the study's cohort as well. Rather than enjoying a stomach full of Mycoplasma, the smaller fish are filled up with other bacteria that may be associated with slower growth and development.

"In the smaller fish, we have found that they are often heavily parasitized by tapeworms, which "steal" energy and feed from the host, suggesting that these fish are less healthy. We also see lower abundances of Mycoplasma. So Mycoplasma's presence in the gut microbiome seems to play an important part for fish health. The next step is to see if certain strains of Mycoplasma are more associated with healthy and large fish" Jaelle Brealey says.

*The gut microbiome of farmed Atlantic salmon is dominated by one bacterial species specific to salmon, Mycoplasma salmoninae, although it is at lower abundances in smaller fish.*

[1]https://www.fhf.no/prosjekter/prosjektbasen/901436/




Bacteria composition plot

## A new tool towards more sustainable aquaculture

These novel findings have been made possible by HoloFish's use of the hologenomic theory, arguing that host organisms and their associated microbiomes should be considered as a single unit, the holobiont. Through this perspective, the researchers have also discovered that the tapeworms found in farmed salmon all have a microbiome of their own that has a different species of Mycoplasma, and that this may be interacting with the microbiomes of the salmon.

"It all comes back to hologenomics and this notion of the holobiont, emphasizing that it is not enough to look at just the host or the host's microbiome in isolation. We need to look at what is inside the host, such as these tapeworms with their own microbiomes, and look at how these additional elements affect the host. We need to consider the entire picture," Jaelle Brealey says.

HoloFish thereby points at new ways to significantly improve aquaculture in a variety of interconnected ways.

Understanding how to better care for the full scope of the salmons' health translates into better fish welfare, making it a more sustainable endeavour by enabling better and more efficient production.

"This will hopefully give us a better idea of how to manipulate the host microbiome with pre- or probiotics, or maybe even modify the salmon genome itself through selective breeding to improve the putatively good interactions with Mycoplasma we observe," Jaelle Brealey concludes.

## We have only just started

The journey towards aligning hologenomics approaches to the challenges faced by aquaculture today is continuously being explored. The researchers behind HoloFish are currently looking to expand their focus towards other fish farmed systems by increasingly thinking about host-microbiota relationships to further improve fish health.

One such project is the large EU funded H2020 project HoloFood (www.holofood.eu) that is at the forefront of salmon aquaculture hologenomics towards sustainable feed solutions.

A key feature of such an ambitious project is the constant need for communication between industry and academia. The project is currently conducting a survey to capture the needs and manufacturing challenges of the food production chain, especially within aquaculture, and the main findings will be shared in the upcoming September issue of Aquaculture Europe. There is still time to participate and we would greatly appreciate your thoughts and input here https://www.chr-hansen.com/en/Animal-Health/landing-page/HoloFood_Co-Lab"

HoloFood
Hologenomics for sustainable food production
Horizon2020
2019-2022

A HoloFish member is sampling gut content (digesta) from a salmon intestine.

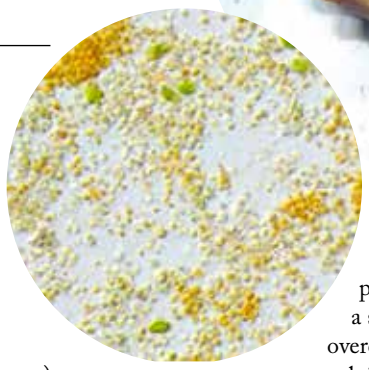
A cryotube with a tapeworm stored in ethanol that was sampled from an infected salmon.

Prepared cryotubes waiting to be filled with a gut epithelium tissue sample for the study of host gut - microbiota interactions.

# Development of bivalve diets formulated with industrially produced microalgae

Figure 1: Juvenile C. *angulata* oyster.

Figsure 2: Microscopic observation of Diet 2 multialgal formulation.



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Shellfish aquaculture is in expansion. In Europe, mollusc production reached 655 thousand tons in 2018 and it is forecasted to reach 869 thousand tons in 20261. In 2018, shellfish production (17.3 million tons) represented 56.2% of the production of marine aquaculture, with *Crassostrea* genus representing 33.2% of global mollusc production3. Due to the high commercial and nutritional value of bivalves, as well as their sustainable production, aquaculture of this low trophic species continues to develop.

In hatcheries, microalgae production represents 30-50%2 of the total production costs, being therefore one of the main bottlenecks of the production. Its high costs are related to the high labour and specialized personnel required, limited daily production, variable nutritional composition of the microalgae and fluctuation in productivity due to technical constraints such as contaminant in cultures and even culture crash. Consequently, hatcheries show an increasing demand and utilisation of industrially produced microalgae in various forms. The European market for microalgae pastes for mollusc hatcheries has an expected Compound Annual Growth Rate (CAGR) of 3.7% (2019-2026)1. One priority in Necton S.A. is the development of new commercial diets with industrially produced microalgae formulated specifically for shellfish and respecting their nutritional requirements, so as to meet this demand.

Global climate changes are greatly impacting shellfish aquaculture production and new mitigation methodologies are required for adaption to the current conditions and to ensure the high production demand. Many shellfish producers relied on the collection of seed from the natural environment for ongrowing in their facilities. However, climate changes promoted a drastic reduction of the natural recruitment and many production companies are increasingly dependent on the seed produced in hatcheries under controlled conditions. Moreover, juveniles that were commonly grown in the natural environment and feeding on natural phytoplankton, nowadays are also being increasingly produced in hatcheries3. This is a successful mitigation strategy to overcome the reduction of shellfish growth in the natural environment due to climate changes. The fluctuation in environmental conditions also affects the available microalgae species and quantities in the water column, thus further affecting the animal's nutrition and growth.

Altogether, these factors lead to higher dependence on hatcheries, with good juveniles produced with controlled nutrition3 and the development of balanced commercial microalgae feeds. These strategies can support the improvement of the productivity and management of the shellfish aquaculture sector under the challenging global changes currently being faced.

## Industrially produced microalgae for bivalve nutrition

Bivalves are healthy resources for human consumption since they have a good profile of essential fatty acids that are important in human nutrition. Bivalve physiology and

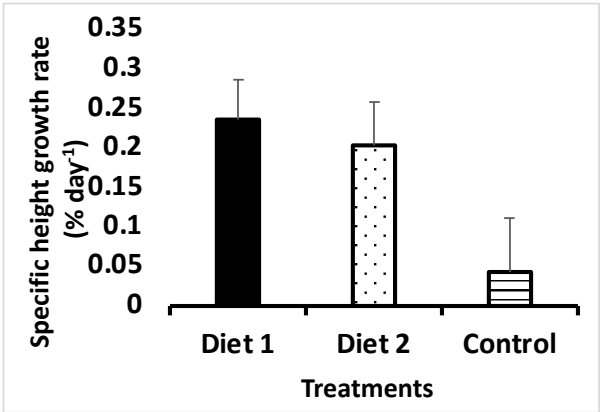


Figure 3: Specific growth rate (% day-1), in height, of C. *angulata* juvenile oysters.

metabolism depend on the availability of fatty acids in their diet, since they do not have the ability to synthesize them. Therefore, they acquire fatty acids through the consumption of microalgae. The fatty acid composition of shellfish reflects the lipids profile present in the diet. Shellfish feeds on microalgae rich in EPA, DHA (n-3 PUFA) and arachidonic acid (n-6 PUFA)4. The most beneficial microalgae for shellfish nutrition are diatoms (e.g. *Skeletonema* sp.) and haptophytes (flagellate species such as *Tisochrysis* sp., *Pavlova* sp.), which are rich in these essential fatty acids. These microalgae are particularly challenging to be produced in the necessary quantities in hatcheries to feed all the production. Therefore, the use of industrially produced microalgae and the development of new commercial formulations is essential.

The development of shellfish diets, including formulations with industrially produced microalgae, is still an immature area, despite research efforts that go back 20 or 30 years. There has been some investigation in dry microencapsulated diets for bivalves, however their efficiency is still poorly understood and producers still consider a risky option. Industrially produced microalgae are the most reliable solution for bivalves' nutrition, since, in the past years, there have been escalating biotechnological advances that allowed the diversification of commercially available microalgae species. Moreover, microalgae biomass quality has been improved through the optimization of culture methodologies, processing and quality control measures. Therefore, nowadays there is available industrially produced biomass of the microalgae species nutritionally relevant for molluscs in different typologies such as paste, freeze-dried, spray-dried and liquid concentrates. Microalgae biomass processing and quality maintenance during shelf life have high control improving reliability of the products. The combination of these products along with the acquired knowledge on the nutritional requirements in aquaculture research, support the development of new nutritional solutions for the aquaculture sector.

The use of different formats of microalgae biomass has been tested, to assess their uptake (filtration) by shellfish. From a practical point of view, the most useful format to be used in a mollusc hatchery is liquid concentrate, since it does not require pre-processing in the hatchery of the product prior its daily utilization, compared to pastes and powders which require steps of hydration, blending and sieving. Where algae is produced 'in house', the maintenance of cultures requires daily activities such as inoculum maintenance, scale up, microscopic observations to monitor contaminants incidence, cell counts and harvesting. Moreover, daily preparation of shellfish diets includes: 1) cell counting of live microalgae from different species, 2) quantification of the necessary volumes of each microalgae species to respect the adequate proportions in the blends, considering the different life stages and number of animals in each tank, 3) preparation of live microalgae blends and 4) feed distribution according to the methodologies established in the facilities (that may include pumps dosage programming). Live microalgae produced in hatcheries are more prone to variability of their biochemical and nutritional value when compared to biomass obtained from companies that are only focused on biotechnology and microalgae production. Therefore, the use of industrially produced microalgae diets allow a higher control of the nutritional content of the microalgae provided to the animals, since they are produced under controlled and optimal conditions. Thus, the use of liquid concentrates would provide a simple and user-friendly solution, reducing greatly the labour cost associated with microalgae production and dietary protocols.

## A new paradigm on industrially produced microalgae formulations for bivalves: A case study in Portuguese oyster

The development of new mollusc diets was performed by Necton R&D department based on techno-economical studies along with investigation into bivalves nutritional requirements. The biological efficiency of the new pilot diets were evaluated in a Portuguese shellfish company. To feed bivalves it is necessary to have microalgae with an appropriate size and shape for ingestion, high nutritional qualities, be readily digested, absence of toxins and does not trigger bacterial contamination. Moreover, bivalve optimal nutrition depends on a balanced combination of diatoms and flagellate species challenging to be produced particularly in industrial scale. Consequently, there is a lack of commercial diets formulated specifically for bivalves, respecting their nutritional requirements. Necton is the oldest microalgal producing company in EU, being particularly proficient on the scale up and cultivation of innovative microalgae species such as *Skeletonema costatum*, *Tisochrysis lutea, Phaeodactylum tricornutum* and *Tetraselmis chui*, that are relevant for bivalve nutrition. The combination of Necton biotechnological advances with the available knowledge in bivalves' nutritional requirements, allowed the development of PhytoBloom® SHELLbreed - an innovative formulation.

Pilot formulations were developed and applied in juveniles of Portuguese oyster (*Crassostrea angulata*) and currently, the validation of the most successful formulation is ongoing in *Crassostrea gigas* broodstock maturation. For that purpose, juveniles of Portuguese oyster were divided into three groups. The control group was maintained in nets in natural environment feeding on the naturally occurring microalgae, resembling the typical aquaculture production conditions. The other two groups were maintained in the nursery in recirculation tanks in duplicate (n=250/replica), being applied two pilot diets. Pilot commercial diets were formulated in a liquid concentrate containing 8% of the dry weight (DW) of industrially produced microalgae biomass, and juveniles were fed daily with an amount equivalent to 8% of the oyster dry meat (g) in DW of microalgae (g). Both diets contained a blend of microalgae species commonly used in oyster nutrition4. Diet 1 was composed by *Tetraselmis chui*, *Skeletonema costatum*, *Tisochrysis lutea* and *Pavlova* sp., whereas diet 2 (Figure 2) was composed by *T. chui*, *S. costatum* and *T. lutea*. Proximal composition of the pilot diets was evaluated through biochemical analysis. Oysters were sampled monthly for 3 months, (n=50/replica) for weight, growth, survival and specific growth rate (K)5 and condition index evaluation.

The analysis of proximal composition revealed proteins, lipids and ashes content of each diet. Diet 1 was composed of 23% of protein content, 10.9% of lipids and 63% of ash content, while Diet 2 consisted of 9.9% of proteins, 2.1% of lipid and 82.2% ashes content. Survival rate did not exhibit significant differences between treatments. Juveniles fed with Diet 2 showed higher increase in wet weight and length and with less variation than Diet 1 and control, along with a higher specific growth rate, in terms of height (Figure 3). A decision tree approach was applied through a CHAID method to the clusters obtained, with wet weight as dependent variable (n=266).

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This analysis revealed that, in small size oyster cluster group, below 40.6mm, Diet 1 and control promoted the highest wet weight. Above this length, Diet 2 was more suitable to improve oysters' weight. Regarding to medium size oysters cluster group, below 40.6mm, Diet 1 caused a higher increment in wet weight, whereas in large size oysters cluster group, below 40mm, Diet 1 and control showed the highest weight, while Diet 2 displayed the highest value for oysters above 40 mm. In conclusion, oyster growth with pilot commercial diets was more constant throughout time than in natural environment. This fact may be due to the fluctuation of the environmental conditions which can promote variability in microalgae species and abundance and therefore, affect oyster growth. Prototype Diet 2 is a balanced diet based on microalgae species and proportions typically used in oyster hatcheries4,6. This prototype diet promoted high and steady growth in juveniles of Portuguese oyster. Higher protein and lipids content in Diet 1 can support the high requirements for growth of smaller oysters, promoting an equivalent wet weight to the oysters grown in natural environment below 40.6 mm. To enhance wet weight gain in Portuguese oysters it is recommend a dietary protocol based on Diet 1 until 40.6 mm and Diet 2 after this length.

This study allowed the validation of innovative microalgae diets specifically formulated for bivalve growth to support the optimization of hatchery management. The shift of monoalgal biomass onto formulations with combined microalgae species for specific purposes and applications is an innovative approach to the development of new and effective products. The successful development of new formulations to feed bivalves will change the paradigm both in biotechnological products for aquaculture and in hatcheries management strategies.


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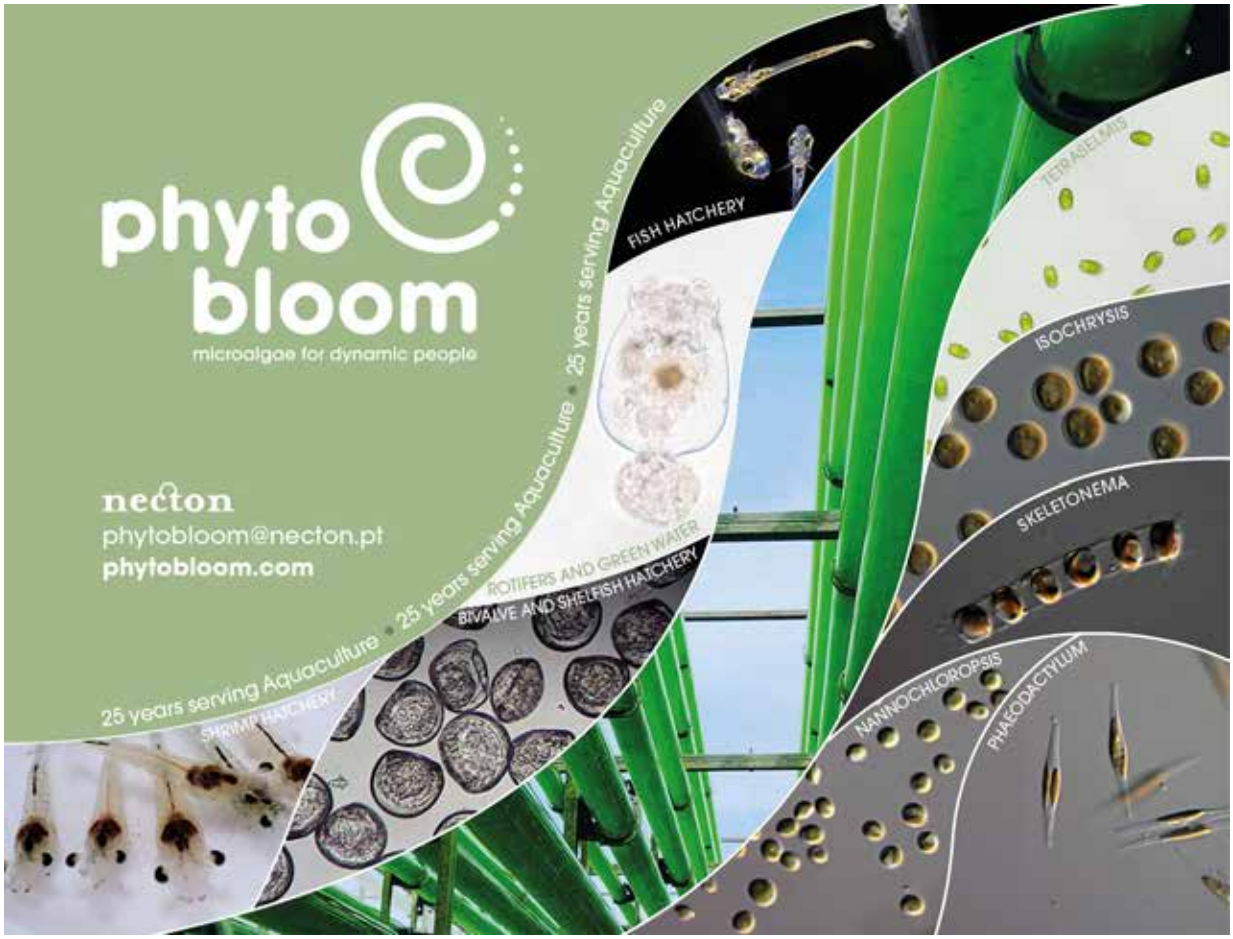


# H2020 VALUMICS Project

## Synthesis of VALUMICS outcomes and policy recommendations

The functioning of food value chains entails a complex organisation from farm to fork which is characterised by various governance forms and externalities which have shaped the overall food system. VALUMICS food value chain case studies: wheat to bread, dairy cows to milk, beef cattle to steak, farmed salmon to fillets and tomato to processed tomato were selected to enable explorative and empirical analysis to better understand the functioning of the food system and, to identify the main challenges that need to be addressed to improve sustainability, integrity, resilience, and fairness of European food chains.

The VALUMICS system analysis was executed through four operational phases starting with Groundwork & analysis including mapping specific attributes and impacts of food value chains and their externalities. This was followed by Case study baseline analysis, which provided input to the third phase on Modelling and exploration of future scenarios and finally Policy and synthesis of the overall work (Figure 1)

This is the last of several articles on VALUMICS published in *Aquaculture Europe* and it is focused on the outcomes of **Phase 4: Policy and Synthesis**. It is a very condensed summary of the full deliverable 8.4, cited at the end of the article.

The goal of the deliverable is to provide an overall synthesis of the VALUMICS results as follows:

- Key findings from the VALUMICS project on the functioning of European food value chains and their impacts on more sustainable, resilient, fairer, and transparent food system are summarised through a compilation of 25 Research Findings and Policy Briefs.

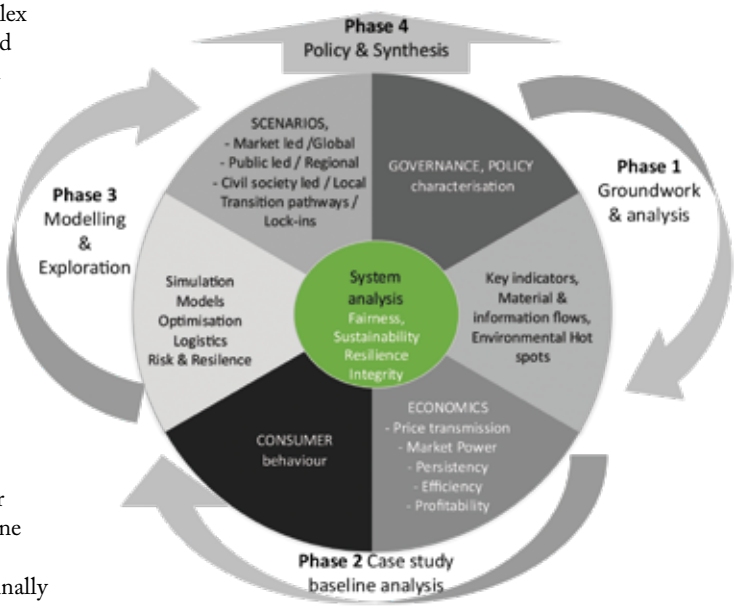


Figure 1 VALUMICS operational phases and the specific research areas focusing on better understanding the dynamics of food systems with the objective to enhance fairness, sustainability, resilience and integrity through baseline analysis of FVC case studies, modelling and future scenario exploration.

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- By highlighting the major contributions from the research activities throughout the four phases of the VALUMICS project, this report delivers an assessment of various factors influencing sustainability, resilience, efficiency and fairness and effective chain relationships of different food value chains, and their determinants.
- The synthesis of the outcome allows the identification of opportunities and challenges characterising the functioning of food supply chains, and thus, the prospects and potentials for strengthening the EU food sector.

It is a compilation of briefs presenting the overall VALUMICS research findings and synthesis of policy recommendations – and directed towards stakeholders / industry policy managers, and governmental policy makers.

The VALUMICS interdisciplinary research activities focused on policy and governance analysis, material and information flows, life cycle assessments, economic analysis, modelling approaches to optimize logistics, and process optimisation to mitigate risk and enhance resilience. Furthermore, simulation modelling of FVC agents´ decisions was developed with the aim to enable evaluation of the impact of future policy interventions on fairness in terms of fair value distribution and employment in the food value chains. Consumer behaviour studies provided recommendations to enhance sustainable consumption behaviour. Finally, foresight scenarios and transition pathways to a more sustainable food system were explored, and policy implications addressed. Particular attention is devoted to the analysis of the contribution of food systems in promoting fairness and fair value distribution in food value chains, employment opportunities and fostering economic growth within the EU, while exploring pathways towards transforming food systems and ensure more sustainable production and consumption which supports the emphasis in the current scientific and high-level policy literature and the EU Green Deal and Farm-to-Fork strategies.

The EU strategic policy and legislative framework and in particular the Farm-to-Fork strategy, the new Common Agricultural Policy (CAP) and the new strategic guidelines for aquaculture (all of which were launched during the later stages of the VALUMICS project) have the potential to successfully support a transformation of European food value chains towards fairness, resilience, transparency, and sustainability targets. However, such a transformation must be supported by food system actions involving all food value chain actors, from farmers to processors, retailers, and consumers and including also a wider perspective of integrated food system and policy.

Policy measures must ensure a holistic and coherent approach by co-ordination of both supply and demand sides. Importantly, ambitious aims to tackle the sustainability challenges of the European food system should consider unintended consequences for the competitiveness and economic profitability of the agri- and livestock sectors, while at the same time realising that action is needed to ensure a food system that is beneficial to the climate, biodiversity, and health. The ongoing Covid-19 pandemic, whose onset was at the final stage of the VALUMICS project, exposed weaknesses in food systems' functioning and further underscored the importance of ensuring fair, resilient, transparent, and sustainable European food systems.


## Short summaries of VALUMICS Research Findings and Policy briefs

### Phase 1: Groundwork and food system analysis.

#### 1. Food system analysis - VALUMICS case studies

A food system thinking approach was applied in co-creation workshops during the first phase of the VALUMICS project in 2017- 2018, with the objective to build a conceptual modelling framework for generic food value chains and systems. Food value chain case studies served as enablers of the overall knowledge building and development work in VALUMICS and provided the scope of scenarios to explore the functioning of food value chains and systems using various analysis tools and modelling.

- Wheat to bread (Czech, Germany, France, UK)
- Beef cattle to steak (UK, Germany)
- Dairy cows to milk (Ireland, UK, France, Germany, and Vietnam)
- Salmon to fillets (Norway and export to EU)
- Tomatoes to processed tomatoes (Italy)

#### 2. EU policies promoting Fairer Trading Practices, Food Integrity and Sustainability Collaboration along European Food Value Chains

This brief presents the updated findings of a mapping exercise, carried out in 2017-8, of the different European Union (EU) policies and governance actions impacting upon food value chains, with a focus on fairer trading practices, food integrity (food safety and authenticity), and sustainability collaboration.

The findings detail the processes and drivers of the EU's policy, and how its policy activity is impacting on food value chain dynamics and is seeking to improve their effectiveness. A characterisation framework was developed to clarify the forms that EU policies take across multi-levels of governance. This framework was used to organise and understand the range of types and levels of policy action identified in the mapping.

#### 3. Norwegian Salmon Value Chain: Flow of products and decision mechanisms

Salmon case study in the VALUMICS project represents the Norwegian farmed salmon chain with production and primary processing in Norway, export and secondary

processing in Europe (mainly in Poland and France) and final distribution in Europe. Mapping of product flows, decision making mechanisms and factors influencing these decisions in the salmon value chain provided input to VALUMICS model developments.

### 4. Food Chain Impact: Market matters

### 5. Novel Solutions for Food Chain Climate Impact Reduction

Life cycle assessment was performed to identify environmental hotspots and improvement opportunities in selected case studies. Potential climate reduction of animal-based foods using novel technologies were identified.

- Farm production stage: novel feed ingredients
- Airfreight in the logistics stage: sustainable fuel
- Food waste: waste prevention and reduction programs
- End market matters

Studies that have focused on production of foods, processing of food and even full system assessment of foods can lead to poor policy if the impact of the end market is not recognized. The end market causes two important drivers of difference in eco-efficiency: rate of wasted food and type of transport. The farm remains the greatest impact hotspot, however, airfreighting can become the dominant hotspot

## Phase 2: Case study baseline analysis

### 6. The governance of European Food Value chains

Governance issues in European food value chains, and their implications for various stages and actors along the chains were explored through eight case studies in different countries. Governance and relationships, value distribution, power asymmetries including perceptions of fairness and information exchange along food chains were explored and assessment of collaborative governance forms. Research into the governance of five food value chains identified a range of features and characteristics specific to each sector, and common themes across all chains, including that actor at key stages of each value chain may be in a better structural position than others, which can give them an advantage in the negotiations and bargaining over contracts; and that governance is changing due to increasing levels of corporate concentration at different stages of the chain.

Along with these inter-firm relations, governance also involves private governance initiatives - such as technical standards - and public policy intervention, including the "EU Directive on unfair trading practices in business-to-business relationships in the agricultural and food supply chain"; support for producer organisations; and voluntary codes of practice

Economic analyses with a focus on analysis of price transmission, market power, persistency of trade, technical efficiency and profitability provide an evidence base to better understand the functioning of the selected food value chains.

### 7. Norwegian salmon value chain: how does it influence the EU markets?

- Producer driven global value chain
- Hybrid governance
- Trading partners easily switched
- Efficiency comes from scale
- Productivity driven by technical efficiency
- Export price in Norway influences price along the value chain

### 8. Market orientation: Dairy value chain in Germany, France, and UK

- Milk producers don't have a strong bargaining power towards processors (there is a long-term negative price/cost ratio).
- Dual pricing system between raw milk producers and processors.
- Raw milk price changes are completely transmitted to consumer-ready dairy products in the long run.
- Adjustments in the scale of operations provide considerable space for productivity improvements in milk production even though the size adjustments in the direction of optimal size were the main source of productivity growth in milk production after milk quota deregulation/abolishment.
- Most milk producers and processors operate near the production frontier.
- Technological change was the source of productivity improvements in milk processing.
- Stable long-term trade with EU partners compared to non-EU (no intra-EU trade barriers and perishability of the end product play a crucial role).

### 9. Market orientation: Wheat-to-bread supply chain in France and UK

- France pays an important role in setting the global wheat reference price.
- UK has higher concentration of actors along the wheat-to-bread value chain compared to France.
- Market imperfections are mainly present in milling industries (on input markets);
- Small millers and bakers operate in niche markets to obtain higher markup.
- Adjustments in the scale of operations provide considerable space for productivity improvements in cereal production.
- Milling and baking industries indicate optimal size of operations and high overall technical efficiency.
- France has more persistent trade relations with EU partners compared to non-EU (lack of intra-EU trade barriers plays the crucial role).

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### 10. Italian processed tomato value chain: market competitiveness, efficiency, and pricing mechanism

- Dual-level governance
- Interbranch Organisation (IBO) plays a crucial role in price setup and balancing of power between producers and processors
- Market power switched towards producers
- Efficiency of small producers comes from the increasing scale of operations
- Unfair trading practices remain downstream in the value chain

### 11. Role of regional policies in multi-level governance of agri-food value chains: Emilia Romagna

Results of the analysis of Italian policies, regulations and initiatives that impact agri-food value chains with specific focus on the Emilia-Romagna region along with stakeholder interviews demonstrated how regional policies may effectively support the national (and European) regulations. Regional policies identified in this brief refer to Emilia-Romagna region, located in north-east Italy.

### 12. Profitability in the European food industries

- The European food industries are charaterized generally by low margins
- Both firm and industry effects explain variations in firm-level profitability
- Larger firms in the food industry are generally more profitable
- Lower returns are witnessed where there are many, smaller firms competing
- Short term debt is associated with lower returns
- While margins are generally low, growth niches exist which offer opportunities for higher profitability

**Consumer behaviour studies** underpin the understanding of the functioning of the food system. To achieve food consumption change, it is crucial to better understand the motivations and contexts behind consumer behaviour and how this relates to the rest of the food value chain

### 13. Food Consumption Behaviours in Europe

Understanding food value chains and network dynamics is highly relevant to identify pathways for a sustainable, healthy, and nutritious food future in Europe. In addition, there is also growing concern that current mainstream consumption patterns contribute to unfair trading practices in food value chains across the EU. In this context the "*Food consumption behaviours in Europe*" report, through research, consumer focus groups and expert interviews, brings together evidence and deeper understanding of EU food consumption behaviours, particularly in relation to the consumption of food products such as beef, salmon, dairy products, tomatoes, and bread. The results provide further knowledge about consumption patterns, drivers, barriers as well as current trends. On basis of interviews with experts from the key food stakeholder groups, potential "pathways" or opportunities towards enabling more sustainable food consumption practices in the EU were identified

### 14. Behavioural insights for sustainable food consumption

Which interventions work? Which ones fail? The VALUMICS report *"Putting solutions on the table"* analyses and showcases the latest and most compelling pieces of evidence about behaviourally informed interventions that support a shift towards more sustainable and healthier diets in real-life contexts. The report is particularly targeted at policy makers, retailers, and restaurants to guide them putting this shift forward, but also to the general citizens, to learn about their own possible behaviour change towards this path

### 15. Making sustainable food consumption a reality

How can we move from attitudes and intentions to action and generate behavioural change towards more sustainable food consumption in Europe? The findings and insights of the VALUMICS report '*From intention to action*' help answer this question by making recommendations to various stakeholder groups on how to support sustainable consumption of food. Sustainable food consumption is understood as food purchasing and consumption patterns that are based on plant and fruit-rich diets with fewer animal-based products, locally sourced and organically produced food, and with less food waste and/or food packaging.

The VALUMICS specific recommendations for increasing sustainable food consumption are based on behavioural insights and are targeted to three main actor groups: policymakers, food industry actors and civil society. The recommendations are largely aligned with and can provide evidence-based support for the implementation of the Farm to Fork Strategy.

## Phase 3: Modelling and Future Scenario Exploration

**The modelling objective** was to develop an integrated approach and use for the analysis of external and internal drivers influencing the performance of food value chains and demonstrate options for improved business strategies.

### 16. Environmentally Conscious Transportation and Logistics Modelling for Agri-Food Supply Chains: An Application to Norwegian Salmon

A logistics mathematical model is proposed, drawing on evidence from the VALUMICS case study of a globally integrated food supply chain, i.e., a Norwegian salmon. The modelling aims to optimise the cost and effectiveness of logistics operations. It also allows for the integration and consideration of environmental aspects within transportation, processing, and distribution operations. A move away from road transport to moving goods by sea wherever possible could significantly reduce both total costs and overall carbon emissions. However, judgements must be made about the relative benefits on a case-by-case basis

### 17. Framework for risk and resilience in food value chains

Agent Based Modelling is a powerful way to model the preferences and actions of heterogeneous members of a supply chain via autonomous agents, combined with the ability of DES (Discrete Event Simulation) to model the queueing behaviour of internal production processes. The resilience of a supply chain to a series of disruptions can be assessed and the impact of a range of approaches to increase resilience can be evaluated. With specific focus

on the Norwegian salmon supply chain, the interaction between various actors such as feed suppliers and producers is modelled using an agent-based framework (ABM).

### 18. Conceptual system model and operationalisation of fairness in food value chains

A system thinking approach was applied for the conceptualisation of a simulation model developed in the VALUMICS project. The undesirable behaviour of the system which was prioritised for the modelling was fairness in food value chains. The system conceptualization phase analysed the underlying feedback structure and the causalities of how behaviour is generated in the system, and this was presented as a mental model in the form of a Causal Loop Diagram (CLD). The subjectivity and intangibleness of fairness perceptions make them difficult to operationalize in a quantitative model. Therefore, to identify a quantifiable measure of fairness as an output of a simulation model the factors related to interorganisational fairness (IOF) which contribute to procedural and distribute fairness were explored.

### 19. Implementation of system dynamics and agent-based modelling simulation of fairness in food value chains

The steps carried out in the development and implementation phase of the hybrid system dynamics and agent-based model following the initial conceptualisation phase of the simulation model are further explained. The system analysis work was an iterative development in the conceptualisation phase and through technical analysis the model was implemented as a policy scenario simulator for a generic four-echelon FVC, then specialised to the VALUMICS case study FVCs: French wheat to bread; North Italian region raw tomato to processed tomato; and Norwegian farmed salmon to fillets.

**Future scenarios:** The objective was to build foresight scenarios to reflect on the possible evolution of selected food chains and on the kind of public, private, and civil society instruments that would enable enhancing their desirable outcomes or counteract their negative impacts

### 20. Anticipatory scenarios for sustainable, resilient efficient and fair food value chains on the basis of contrasted paradigms

Anticipatory long-term (2050) target scenarios were created that all fulfil the objectives of being sustainable, efficient, fair, and resilient, but relying on contrasting worldviews or paradigms with their underlying assumptions and consequent governance systems and actor behavioural patterns. The aim was to enlighten a broad range of options to reach the objectives (not to compare, which scenario is 'best' and not to predict which is most probable), available to be implemented in potentially distinctive spatiotemporal contexts, and to be combined in varied mixtures.

### 21. Towards a Sustainable and Fair EU Food System in the EU: Challenges and Conditions of a Protein Transition

The publication of the Farm2Fork Strategy paves the road for an ambitious transformation of the EU food system to address environmental, health and social issues and deliver on sustainable and healthy diets for all. The "protein transition" – i.e., the decrease in the consumption and production of animal products while increasing that of pulses - represents a key component of this transformation and is especially crucial to reduce the environmental pressures currently exerted by the food system (GHG emissions, biodiversity loss, water, and soil pollution, etc.).
The long-term direction of travel of the protein transition gathered a consensus among the VALUMICS Workshop Series Participants, while three key questions were addressed: **(i)** What are the specific challenges associated to the reorganisation of key food value chains? **(ii)** What are the key policy changes required to trigger those transformations? **(iii)** What sort of collective action is needed to kickstart this process? The discussions focused on three value chains of key importance for the protein transition: plant proteins, wheat, and dairy.

The results highlighted that the protein transition will depend on the collective action of actors within food value chains: policy makers and economic actors can no longer pass the buck to each other or wait for consumers to drive the change. All actors of the system need to move in the same direction to create cumulative effects and ultimately overcome the macro socio-political lock-in of our food system.

### 22. Policy conditions for a just transition of the French wheat and dairy sectors

The modelling results demonstrate that a climate-focused transition pathway based essentially on a change in supply-side policies but with minor interventions on demand and market organization, would have significant socio-economic impacts. In contrast, the results of the local policy-led scenario for the two sectors studied make credible the hypothesis of a just transition of the food system. The economic viability

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of such a scenario depends, however, on a simultaneous transformation of supply, demand, and market organization - and therefore on major policy changes in these three areas.

### 23. Transition pathways towards more sustainable salmon aquaculture

Industry stakeholders´ views were analysed through integration of Multi Level Perspective framework and an extended Global Value Chain governance framework for the salmon value chain. Although landscape pressure, specifically related to global environmental change and changing consumer preferences, seems to be reasonably high and on the rise, it continues to be offset by the resistance to change by powerful actors in the regime and their ability to adapt and align their production network enough to alleviate some of the pressure. Furthermore, competitive niche-innovations, such as land based, and offshore farming systems, do not seem to be sufficiently developed to compete with the highly efficient traditional sea-based farming systems. Therefore, a gradual transformation towards more sustainability within the current regime with, mainly, regime driven innovations and refinements is the most likely in the near future.

## Research findings and Policy Briefs from Vietnam

### 24. Exploring the governance and fairness in Vietnam's milk value chain

Under the high pressures of globalisation, climate change, and changes in consumer behaviour, Vietnam's milk value chain has been notably upgraded in a more sustainable and modern way. The government's regulatory interventions have also had considerable influences on the fairness, welfare, sustainability, and governance in the milk supply chain. However, not all dairy farmers have benefited from these supporting policies and schemes. Thus, the regulatory interventions on enhancing of the fairness and welfare to dairy farmers should be diverse, gradual, and inclusive.

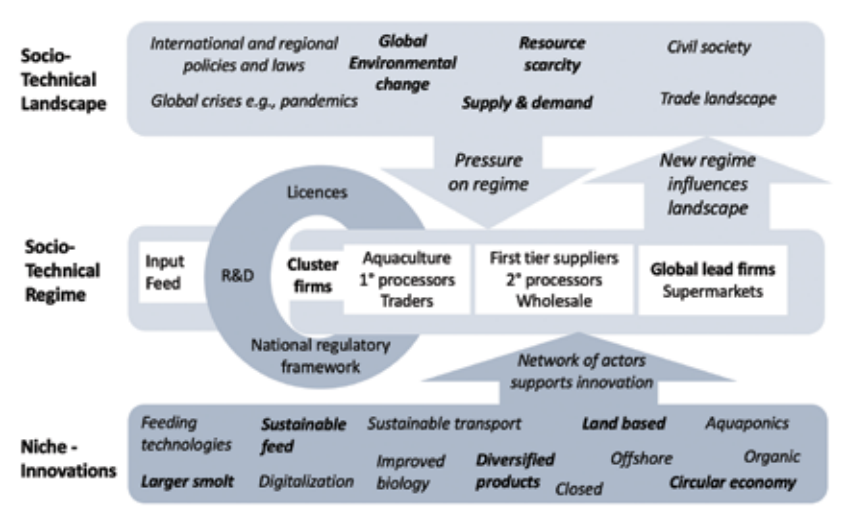
### 25. Milk Consumption Behaviour Analysis in Vietnam

An international perspective from Vietnam contributing to the research on food consumption behaviours within the VALUMICS project. The study identifies the key drivers and barriers to sustainable and fair milk consumption and proposes an intervention design to improve food consumption patterns through focus groups and a food consumption behaviour model. The key findings show that health aspects and taste are the most important drivers of milk consumption while milk price and the place of purchase are the strongest restrictions

## Transition pathways towards more sustainable salmon aquaculture

**The last part of this article focusses in more detail on the brief #24 above on transition pathways to more sustainable salmon aquaculture.**

It summarises key findings from exploration of transition pathways for salmon aquaculture based on integration of Multi Level Perspective framework and an adapted Global Value Chain governance framework for the salmon value chain




Summary findings through the integrated framework (based on existing frameworks)
Source: Gudbrandsdottir et al., 2021

Sea-based salmon aquaculture is one of the most advanced and most efficient animal-based food supply chains. Salmon is a rich source of protein, healthy fats and micronutrients necessary in the promotion of healthy diets. There are, however, several local environmental impacts associated with sea-based salmon aquaculture, such as sea lice, escapements, disease, eutrophication, and algal blooms as well as carbon emissions from the whole value chain e.g., in relation to feed production and transportation of feed and products.

The governance of the global salmon value chain is a hybrid of national state led governance and voluntary third-party certifications and the inter-firm relationships can vary from free market exchanges to a hierarchy governance of integrated firms. The large integrated salmon firms are typically owned by the producers who drive technical innovation. The powerful position of aquaculture producers and the mutual dependencies of business actors,

aiming to maximize their profit, and the government, depending on businesses to provide jobs, tax payments and economic growth, highlights the importance of considering the role of power and resistance or motivation to change in transition studies.

In terms of innovation and industrial development, the success of salmon farming in Norway is based on close cooperation between industry actors, governmental bodies and research institutes which contribute to a strong cluster. The hybrid form of governance, which is a mix of traditional state-based regulations (such as licenses) and voluntary instruments (such as certifications), indicates flexibility and ability to adjust. There are powerful value chain actors and networks of actors with vested economic interests in sustaining the current regime. Specifically, large integrated producers are in a powerful position in the chain, and they are heavily invested in the traditional form of sea-based salmon farming. Their hybrid governance structure also makes it easier for them to adjust to landscape pressures through incremental adjustments (symbiotic niches) to the prevalent technology of open net pens.

Although landscape pressure, specifically related to global environmental change and changing consumer preferences, seems to be reasonably high and on the rise, it continues to be offset by the resistance to change by powerful actors in the regime and their ability to adapt and align their production network enough to alleviate some of the pressure. Furthermore, competitive niche-innovations, such as land based, and offshore farming systems, do not seem to be sufficiently developed to compete with the highly efficient traditional sea-based farming systems. Therefore, a gradual transformation towards more sustainability within the current regime with, mainly, regime driven innovations and refinements is the most likely future.

**Policy Recommendations**

- Broadening stakeholders' perspectives, in particular policymakers and NGOs, and reframing aquaculture challenges in a food system perspective is important for transitioning the industry towards more sustainability. The whole salmon value chain and its role in the wider food system must be considered when assessing sustainability outcomes
- Seafood has an important role to play in sustainable and healthy diets due to its nutritional profile and its relatively lower environmental footprint than most of livestock production. Integration of fish in food policy especially in relation to the protein transition, i.e., reducing the amount of animal proteins in diets, is crucial.

*Reference*: Gudbrandsdottir, I.Y.; Saviolidis, N.M.; Olafsdottir, G.; Oddsson, G.V.; Stefansson, H.; Bogason, S.G. Transition Pathways for the Farmed Salmon Value Chain: Industry Perspectives and Sustainability Implications. Sustainability 2021, 13, 12106. https://doi.org/10.3390/su132112106

**VALUMICS briefs - Further reading**

Deliverable D8.4 Scenario Analysis report with policy recommendations compiles the VALUMICS Research Findings and Policy Briefs. The briefs were created by VALUMICS partners who contributed to the research reported in earlier VALUMICS deliverables.

*Citation: Ólafsdóttir, G., Aubert, P.M., Barling, D., Holden N.M., Thakur., M., Duric, I., Jaghdani, T.J., Čechura, L., Svanidze, M., Samoggia, A., Monticone, F., Esposito., G., Nicolau, M., Fedato, C., Xhelili, A., Huber, E., Saviolidis, N M., Gorton, M., Hubbard, C., De, A. McGarraghy, S,. Hoang, V., Bogason,S. (2021). Scenario analysis report with policy recommendations An assessment of sustainability, resilience, efficiency and fairness and effective chain relationships in VALUMICS case studies. The VALUMICS project funded by EU Horizon 2020 G.A. No 727243. Deliverable: D8.4, University of Iceland, Reykjavík, 130 pages*



**H2020 VALUMICS – Understanding Food Value Chains and Network Dynamics**

Coordinating partner: University of Iceland, Dunhagi 5, Reykjavik, Iceland – https://www.valumics.eu

**The reference to the deliverables, special reports, and scientific publications is detailed in the briefs and key contacts for more information.**

**The individual briefs are also available on the VALUMICS website. www.valumics.eu**

VALUMICS
Food Systems Dynamics

*"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727243"*

# ASC launches largest ever public consultation on new ASC Farm Standard covering all ASC certified species

ASC has launched one of its largest ever public consultations to seek stakeholder feedback on the upcoming ASC Farm Standard, which will enhance the efficiency and accountability of the ASC programme for the benefit of all stakeholders.

The development of the Farm Standard represents the biggest overhaul of ASC certification programme since its beginning. The single Standard covering all ASC species will drive efficiencies into the system and enhance the ASC's impacts.

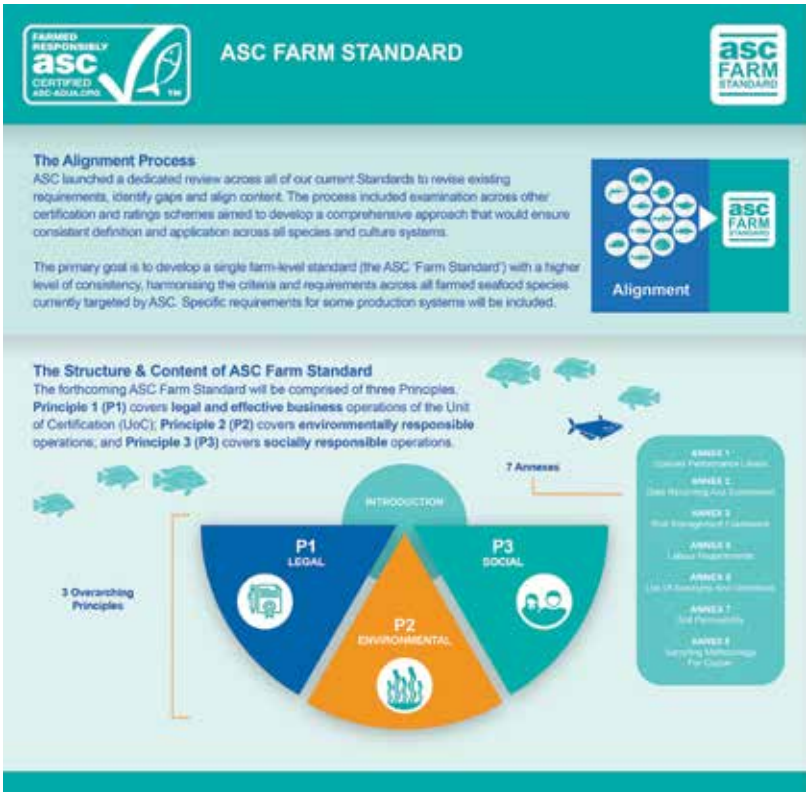
Several explanatory videos are available on the ASC YouTube channel. See also the infographic.

Farmers and auditors will benefit from greater efficiencies, while other stakeholders including NGOs will find it easier to assess and compare the ASC's requirements, making public consultation more efficient.

This round of public consultation covers the entire Standard, except for fish welfare which was the topic of a separate public consultation in 2021. Ultimately, this fish welfare content will be adopted into the ASC Farm Standard.

ASC's Director of Standards and Science, Michiel Fransen, said: 'ASC's Farm Standard will address all main impacts of aquaculture in a consistent manner across the industry in a more effective and efficient manner.

'We are now coming to the final stages of this project, and are asking for stakeholder feedback so we can be sure the final Standard will meet expectations of all those that will use it.'




Stakeholders can view details on the proposed Farm Standard and ways to provide feedback, including through a survey and by joining workshops, on the ASC website.

https://www.asc-aqua.org/programme-improvements/aligned-standard/

**The consultations will run for two months, from 1 March to 30 April 2022.**

This round of consultation covers a number of vital issues including proposals for requiring all certified farms to report energy use and greenhouse gas emissions, a proposal aimed at combatting sea lice, and the introduction of Risk Management Plans for key topics like health and safety.

By developing one comprehensive standard covering all these impacts, ASC will be able to respond to changes in the markets and industry more swiftly. All new developments or reviews will continue to be developed by multi-stakeholder governance groups and undergo public consultation – all in line with best practices according to ISEAL.

ASC will conduct a final round of consultation on the environmental criteria later this year, while also carrying out on-farm pilots to understand where clarification in Standard writing is needed which elements need guidance for implementation. Principle Two will be finalised and sent to ASC's Supervisory Board for approval in September 2023 with an aim of publishing thereafter.

Find out more and get involved in the public consultation at the ASC website https://www.asc-aqua.org/


The issues of compatibility and mutual synergy between the users of marine, brackish and freshwater resources and their relationship with the quality of those ecosystems are central in promoting the sustainable development of the Blue economy and aquaculture.

Traditional and emerging Blue economy sectors, currently operating in the Adriatic, Mediterranean and water bodies throughout Europe, are expected to grow and expand over the next years and to sustainably contribute to food production, biofuel and clean energy.

Nevertheless, scientific literature provides clear evidence that, according to current trends and within 10 years, our coastal and marine environment will change for sea acidification and warming, sea-level rise and coastal erosion and all water bodies will be affected by flooding, eutrophication and pollution, with important effects on ecosystem services, fish and shellfish stocks and food security.

Climate change, depletion of natural resources, loss of biodiversity, food security and safety, environmental pollution and waste represent important sustainability challenges for further expansion of European aquaculture and the ambition of the European Green Deal and the Farm to Fork Strategy. It will be necessary for the sector to address these externalities, but also focus on the way in which we chose, use and re-use resources, as we move towards a circular Blue economy.

How aquaculture is facing these challenges, and the solutions put in place to develop a sustainable, responsible and productive and climate neutral European aquaculture sector for key marine and freshwater fish, shellfish and algal species are the main themes for AE2022 event in Rimini.

## Plenary sessions

The AE2022 Plenary sessions will address the three main themes from the scope of the event; notably changes to our environment, the move towards circularity and innovative solutions. Planning of these is still ongoing, but the sessions will be a mix of presentations and panel discussions. One the sessions and presenters/panellists are confirmed, we will post details on our website and disseminate widely.

*continued on page 34*

Borgo San Giuliano — Photo credit: @italiaoffroute.it

Rimini Boat Tour — Photo credit: @gentjancetaj

Piazza Tre Martiri — Photo credit: @PeterFineart

## Parallel sessions

The following parallel sessions are open for abstract submission https://www.aquaeas.org/Abstract/Submit/AE2022 and our session convenors are currently working to promote their session. Please ensure that you submit on time. Please also note that oral presentation slots at AE2022 have been shortened from 20 minutes to 15 minutes to allow for more presentations in the conference programme.

- Climate Change
- Conservation & Restoration (all species)
- Environmental impact and interactions
- Nature-based solutions and ecosystem services
- Ponds, lagoons and wetland ecosystems
- Spatial Planning, Zoning and Protected Areas
- Microplastics & Litter
- Health management – biosecurity and prevention
- Health management – treatment
- Health management - gut health
- Welfare
- Aquaponics
- Integrated Multitrophic Aquaculture (IMTA)
- Algae for Biomass, Energy, Cosmetics
- Early life stages
- Hatchery management
- Reproduction & broodstock management
- Selective breeding
- Emerging Aquaculture Species
- Percid Fish Culture
- Shrimp production
- Shellfish production
- Micro- and Macro- Algae
- Nutrition - Physiology & Requirements
- Nutrition - Technology & Precision feeding
- Nutrition - Functional ingredients
- Nutrition: Digestibility and Sustainability
- Offshore & Multi-use
- Optimising water usage in land-based systems
- Water and solids treatment (including disinfection)
- Modelling, robotics, automation and control system applications
- Epigenetics
- Genomics
- Microbiome & metagenomic applications
- Market and value addition
- Socio-economic challenges for sustainable aquaculture in a changing environment
- Processing, co-products and value addition
- Animal Testing - the 3Rs - Replace, Reduce and Refine

Rimini Beach Photo credit: @graymalin.com

## Special sessions and workshops

The Aquaculture Europe events are all about communication with the sector. AE2022 will feature a special international trade exhibition, where Italian and international companies will present their latest products and ser-vices. Standard and Corner booths are available and each booth is 6m2 (2x3m) and features walls, carpet, two chairs and one table, spotlights, one power outlet, fascia identification sign and two free full delegate registrations for the conference. Additional staff can register through the booth contract at significantly reduced rates.

The AE events also feature an **Industry Forum**, where presentations and panel discussions focus on relevant and time-ly issues for the sector. Since 2019, AE also incorporates an **Innovation Forum** looking to help accelerate new companies. This year, the forum will be organised by the European Aquaculture Technology and Innovation Platform, the European Commission and EAS. It will take place all day on Thursday, September 29 and be based on the creation of the correct circumstances for the successful uptake of innovation solutions across aquaculture value chains, where multiple knowledge transfer and facilitation routes (including platforms, projects, accelerators, and dissemination/education tools) all have a key role to play in effective innovation transfer and capacity building. Practical demonstrations of initiatives with high innovation potential will be presented as examples both of principles and practice.

The AE2022 Innovation Forum is aimed at industry actors, policy makers, knowledge transfer experts, and those engaging in aquaculture knowledge development and collaboration. It will inform how best to ensure meaningful knowledge & innovation transfer addressing research gaps and priorities for action whilst ensuring impact.

The day before AE2022 starts, EAS will organise the second **RAS@EAS** event, featuring in-depth panel discussions on hot topics within the RAS sector. The one-day workshop will bring together key figures from science and industry to focus on key issues and share experience with different species and systems.

On Wednesday, September 28, the Food and Agriculture Organization of the United Nations will organise an **FAO Special Day** that will focus on a number of relevant international processes and discuss their implications on the development of the European aquaculture sector. These include: "The Global Processes on Sustainable Aquaculture: what does it mean to European stakeholders?" "Genetic Resources in Aquaculture: Managing them Better." "Markets for Aquaculture Products – Recent Changes and Trends." And "Small in Scale, Big in Value: Celebrating the International Year of Artisanal Fisheries and Aquaculture."

The initial programme is on the AE2022 website https://aquaeas.org/_pdf/AE2022-FAO-Special-Day.pdf and further updates will be posted nearer to the event.

Other special sessions include a dissemination and discussion day for the EU PerformFISH project - Integrating Innovative Approaches for Competitive and Sustainable Performance across the Mediterranean Aquaculture Value Chain. Taking place on Thursday, September 26, the day will be split into two parts, with transfer of the high TRL industry-ready outputs in the morning, and an afternoon interactive session to look into future trends & challenges.

The EU BIOGEARS project will organise a world café event entitled "Biobased gears as opportunity towards a circular and eco-friendly aquaculture." More information on that and all the special sessions will be posted at the AE2022 website as it becomes available.

## Student activities

We will once again organise the AE2022 Student Spotlight Award at the first plenary session. All abstracts submitted by students before the May 1st deadline will be eligible, and the three best will be selected by the EAS Board as finalists for the competition. Each finalist will have a three minute pitch presentation and the winner will be selected by the audience.

Our student Group Sponsor SPAROS has also repeated its competition for students and postdocs that are conducting their research on aquaculture nutrition to foster the use of nutritional-based mathematical simulations on their work. The prize winner will attend the event, with flight ticket, hotel stay and conference registration fee offered by SPAROS.

On the first day, the EAS Student Group Workshop will take place and is currently being planned. It will be followed by the Student Reception in a special location in Rimini.

## Location, hotels

Rimini is the Italian province with the largest number of Blue Economy businesses, where tourism, fisheries and aquaculture are the most prevalent sectors by number of blue jobs. For its location on the Italian Adriatic coast, Rimini is the perfect image of the blend of natural and cultural Mediterranean heritages and modern and dynamic aquaculture, where different traditions of valliculture, freshwater and marine farming traditionally coexist in inland, coastal and marine waters, operated by small cooperatives and large consortia of aquaculture producers.

We are currently putting together a list of hotels and suggestions for student accommodation near the Palacongressi di Rimini. This will be posted on the conference website.


La Ruota Panoramica

Photo credit: @PeterFineart

## Sponsors

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### AE2022 Organising Committees

AE2022 Steering Committee: Chair: Alessandro Lovatelli (FAO). Members: Giovanna Marino (ISPRA), Clara Boglione (Univ. Tor Vergata), Giuseppe Prioli (AMA) and Gavin Burnell (EAS Past President)

AE2022 Programme Co-chairs: Maria Letizia Fioravanti (University of Bologna) and Daniel Żarski (Polish Academy of Sciences in Olsztyn)

AE2022 Local Organising Committee: Chair: Giuseppe Prioli (Associazione Mediterranea Ac-quacoltori (AMA)). Members: Paolo Bronzi (World Sturgeon Conservation Society), Andrea Fabris (API, FEAP Fish Health and Welfare), Biagio di Terlizzi (International Center for Advanced Mediterranean Agronomic Studies) and Ales-sio Bonaldo (University of Bologna)

### Important dates

| | |
|---|---|
| **Abstract submission deadline for oral presentations:** | **May 1st** |
| **Abstract submission deadline for Eposter presentations:** | **Aug. 15th** |
| **Early bird registration:** | **July 15th** |

https://www.aquaeas.org/Registration/Submit/AE2022

### Contacts:

Event page and updates: https://www.aquaeas.org/

General inquiries: ae2022@aquaeas.eu

Conference Director: worldaqua@was.org

Booths and sponsorship: mario@marevent.com

**#AE22RIM**

Arco d'Augusto

Photo credit: @livingriviera.it

SUBMIT YOUR ABSTRACT

# INNOVATIVE SOLUTIONS IN A CHANGING WORLD

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27-30 SEPTEMBER 2022

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WWW.AQUAEAS.ORG

# Vacancy for an associate professor/full professor Aquaculture in the Department of Animal Sciences and Aquatic Ecology of the faculty of Bioscience Engineering at Ghent University

At the UGent faculty of Bioscience Engineering, research and academic education in aquaculture are currently found in the Department of Animal Sciences and Aquatic Ecology, which ensures the integration of two core disciplines within 'Blue Growth' (Aquaculture and Blue Biotechnology).

Aquaculture research at Ghent University (UGent) started in the 1970s with research into the unique properties of the brine shrimp, Artemia, and its crucial role as live food in the larval culture of commercially important farmed fish and shrimp species. The international recognition of this research resulted in the establishment of the Artemia Reference Center, which has brought the research group to the world top of larviculture research. Some important lines of research that have been developed over the past decades and that (may) form the basis for future research are: larviculture of fish, crustaceans and shellfish, pond culture of Artemia for both biomass and cyst production, and more recently identification of the Artemia genome, gnotobiotic culture of Artemia as a model organism, and interaction of (larval) hosts with their microbiota with the ultimate aim of contributing, on an industrial level, to "health management in aquaculture".

Also in the field of education, thanks to the international reputation, a 2-year English-taught master degree in aquaculture was established (since the early 1990s). For the past 30 years, the Laboratory of Aquaculture has ensured continuous financial support for this educational program with external means (mainly through Belgian/Flemish government funding from development cooperation). Recently (2020) funding was obtained for an ERASMUS Mundus master program "International Master of Science in Health Management in Aquaculture". This program started in 2021.

In recent decades, the aquaculture sector has experienced rapid growth, but more importantly, progressive professionalization. This was accompanied by a strong increase in the complexity of the (larval) culture processes. This required strong multidisciplinary collaboration in both research and education. The Laboratory of Aquaculture and Artemia Reference Center responded to this by uniting the expertise of other research groups from its own faculty and other UGent faculties into the UGent Aquaculture R&D Consortium and the IOF Aquaculture Ghent University consortium, which was more recently further expanded into the BLUeGent consortium. This reinforcement, by bringing together these diverse UGent expertises, was also reflected in the educational offer within the aquaculture master's program, which resulted in a unique and strong reputation in the educational landscape of the aquaculture world. Continuing the international pioneering role within the rapidly evolving aquaculture sector is a challenge, not at least because worldwide, and in Asia in particular, the number of good-quality local training opportunities at the undergraduate level and/or master level, is increasing. This requires a UGent aquaculture educational program, based on a balanced general education and in-depth knowledge of specific UGent core specializations in order to profile and differentiate internationally. In this respect, the more explicit profiling within the domain of "aquaculture health management" constitutes a strategic choice for the Ghent University aquaculture programs within the international aquaculture educational landscape and offers opportunities to consolidate complementary partnerships for research and education with the strong international network of the Laboratory of Aquaculture and Artemia Reference Center (a.o. via alumni).

**Profile:**

For the coordination, management and further international development of the research and education outlined above and the consolidation of the international role of the Artemia Reference Center, the successful candidate should have broad and global aquaculture knowledge, based on professional experience in the aquaculture sector, and an international network, combined with a strong track record in "health management" in aquaculture/larviculture.

Specific expertise in aquaculture health management, larviculture, and/or Artemia is recommended as this constitutes the core expertise of the Laboratory of Aquaculture and Artemia Reference Center. The research expertise and vision of the successful candidate is complementary to the expertise present in the UGent Aquaculture R&D Consortium. Given the multidisciplinary research context, the aim is to collaborate with members of this UGent consortium for the further development of this research. In addition to research, the successful candidate also coordinates the organization and qualitative implementation of the international master programme(s) in aquaculture of the Faculty of Bioscience Engineering, with recently a strong profiling in the field of "Aquaculture Health Management". As outlined above, the strong international evolution in aquaculture education and the dependence on external funding are major challenges. The successful candidate has a future-oriented and strategic vision on this, based on a good insight into the international educational landscape within the domain of aquaculture.

We aspire to attract an inspiring candidate at the level of associate or full professor who, as a leader, has capabilities to motivate and steer.

**Timing:**

We expect the vacancy to be advertised at the end of March/beginning of April 2022. The recruitment is from September 1, 2022 or February 1, 2023 (depending on the length of the selection procedure and the availability of the selected candidate). If you are interested in this vacancy, please keep an eye out at https://www.ugent.be/en/work/overview.htm

**Information:**

For further information, please contact Prof. Peter Bossier (peter.bossier@ugent.be) current head of the Laboratory for Aquaculture & Artemia Reference Center (ARC) or Prof. Veerle Fievez, department chair (veerle.fievez@ugent.be).

# Adopt a student

## Wasseem Emam and Dennis Wittmann - mentee's point of view

Hailing from Egypt and Canada, Wasseem is a Glasgow-based ecologist interested in improving the lives of fish raised for human consumption. His doctoral research at the University of Stirling is on the welfare of farmed Nile tilapia in Egypt and the implications of further intensification of the aquaculture sector.

I was notified of my EAS mentorship match at a very interesting moment for me — on hiatus from my PhD at the Institute of Aquaculture in Stirling whilst completing a traineeship with the European Parliament's Committee on Fisheries in Brussels, shortly before becoming a dad and not long before the pandemic hit. I was very happy to be 'adopted' by Dennis Wittmann who was working at the Aquaculture Stewardship Council (ASC) in the Netherlands since it was an organisation that had been on my radar for a long time. I had always believed that certification schemes have an important role to play in incentivising sustainable production practices and was aware that ASC was a trailblazer in this space.

During our initial call, we discussed my growing interest on the topic of fish welfare which had started during my PhD and Dennis suggested a few interesting opportunities to pursue. However, given that I was still intending to complete my doctorate part-time, I was looking for casual engagements if possible. We discussed options for working as a freelance consultant and Dennis suggested I give it further thought. When we learnt that ASC was in the middle of developing new standards for farmed fish welfare, Dennis urged me to reach out to the team to learn more about their work. Shortly thereafter, I had a meeting with ASC where we discussed some of my proposed ideas around developing a welfare standard for farmed Nile tilapia and was offered the possibility of elaborating on this idea further during a consultancy stint.

My time at ASC allowed me to better understand the process of developing new aquaculture certification standards as well as the complexities involved in ensuring that diverse stakeholder views are taken into consideration. This experience was a key factor in the decision by the Aquatic Life Institute (ALI) to bring me on board in early 2021. I initially joined ALI as a consultant supporting the team's efforts in advocating for improved animal welfare in aquaculture through close partnerships with certifiers such as ASC. However, given our overlapping values, my relationship with ALI blossomed and I became a core part of both the research and policy teams.

The best part of this was that ALI actively encouraged staff to work flexible hours which allowed me to earn supplementary income whilst focusing on my doctoral studies. This was particularly crucial for a first-time parent in a pandemic. All of this was made possible thanks to the connections forged through the EAS mentorship programme and in particular through all the encouragement and support I received from Dennis to believe in myself and to work to my strengths.

Dennis Wittmann is Market development manager and responsible for the German speaking market at the Aquaculture Stewardship Council (ASC). He uses his Aquaculture background in his work with farmers, seafood processors, retail and foodservice companies, scientists, conservation groups and the public globally to promote the best environmental and social choice in farmed seafood.

# AQUACULTURE MEETINGS

**Direct links, brochures, registration form etc are linked to this information in the EAS website calendar module**

**This AQUACULTURE MEETINGS calendar is a summary of the new events module of the EAS web site…**

To add information on aquaculture meetings that are of relevance to European aquaculture, please send the details to eas@aquaeas.eu and we will then add them to this column.

## MARCH 2021

**BlueInvest Day 2022**
Brussels, Belgium and online, March 28
This year's BlueInvest Day will once again bring together entrepreneurs, investors, corporates, and stakeholders in the Blue Economy. Here's what to expect: more business and investment opportunities; exciting new announcements; and the BlueInvest Award, a Pitch Battle!
There will be a limited number of places available to attend in person, so register now to reserve your spot!
Unable to attend physically? You can still participate in the virtual BlueInvest Day.
Register at: https://na.eventscloud.com/ereg/index.php?eventid=642639&
For info: blue-invest@lu.pwc.com

## APRIL 2022

**AquaPro Expo**
Moscow, Russia, April 12-14, 2022
**International exhibition of equipment and technologies for catching, breeding and processing of fish and seafood.**
https://aquaproexpo.ru/en/

## APRIL 2022

**10th European Algae Industry Summit**
Reykjavik, Iceland, April 27-28, 2022
The conference will once again bring together key players within the algae industry including leaders from food, feed, nutraceuticals, pharmaceuticals and cosmetics across the globe to gain a deeper understanding of recent industry developments and economically viable applications and benefit from excellent networking opportunities.
For more information on the conference and early bird registration please contact Dimitri Pavlyk on +44 203 141 0610 or dpavlyk@acieu.net
More info: https://www.wplgroup.com/aci/event/european-algae-industry-summit/

## JUNE 2022

**Seagriculture 2022 EU**
11th International Conference Seagriculture 2022
Bremerhaven, Germany, June 29-30, 2022
Seagriculture 2022 EU gathers top speakers, who will share their know-how within seaweed for feed, food, offshore cultivation, biorefinery of seaweed and much more.

The two-day program will go into the many different applications of seaweed that exist now and will combine plenary sessions with interactive poster presentations, trade shows and debate sessions, among others
More info: https://seagriculture.eu/

## SEPTEMBER 2022

**Fish International**
Bremen, Germany, September 4-6, 2022
Around 303 exhibitors from 29 nations presented their products in the areas of fish production and processing, fresh fish and delicacies, as well as research and development in February 2020. More than 10,000 visitors from fisheries management, retail and catering took the opportunity for information, networking and exchange. info@fishinternational.de, www.fishinternational.de/en

**5th Percid Fish International Symposium**
České Budějovice, Czech Republic, September 18-23, 2022
Organized by: Biology Centre of the Czech Academy of Sciences, Institute of Hydrobiology (see www.hbu.cas.cz)
Chairman: Martin Čech
(e-mail: carcharhinusleucas@yahoo.com)
Conference programme: Various aspects of the biology of perch (Perca fluviatilis, P. flavescens, P. schrenkii), pikeperch/walleye/sauger (Sander lucioperca, S. volgensis, S. vitreus, S. canadensis) and related species including early life history, ontogeny, population dynamics, behavior, evolution, fish stock management, aquaculture, physiology, genetics (eDNA including), predators and parasites and interactions with other species.
Email: info@percis-v.eu; More info: https://www.percis-v.eu/

## SEPTEMBER 2022

**Aquaculture Europe 2022**
Rimini, Italy, September 27-30, 2022
Theme: Innovative Solutions in a Changing World.
#AE22RIM, www.aquaeas.org

**Contact for abstracts and registration:** EAS Conference Organiser, John Cooksey, MF Cooksey Conference Management, AE2021 Conference, P.O. Box 2302, Valley Center, CA 92082, USA. Tel: +1 760 751 5005; Fax +1 760 751 5003; E-mail: worldaqua@was.org

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european aquaculture society

# Join us!

Membership of EAS is available for ONE year or THREE YEARS or LIFE.

## Individuals members

Individual membership
Students and retires – **FREE OF CHARGE**
Honorary life members

## Organisations members

Institutional membership
Corporate membership

## BENEFITS include:

**"Aquaculture Europe"** magazine (biannual publication). This magazine covers all aspects of aquaculture with a special focus on Europe. Each issue includes a feature article and shorter articles on developments affecting European aquaculture

**"Aquaculture Europe"** e-newsletter, bimonthly (PDF), including details on meetings and events, publications, news items with links, information from the members

an **annual members list** and free listing in it

**online access** to our peer reviewed journal **Aquaculture International** AQUI): bimonthly peer reviewed journal comprising research papers, short communications and technical notes

**reduced registration fees** (membership rate) at EAS or WAS events

eastalk

eastalk podcast

A reduction in the membership fee (only on a one year basis) is available for residents of certain countries

**See more: www.aquaeas.eu/cb-registration**

# ADOPT A STUDENT

EAS mentoring for the new generation of aquaculture experts!

**FOR STUDENTS:**

PROVIDING YOU WEALTH OF KNOWLEDGE AND EXPERIENCE

GIVING YOU THE CHANCE TO INTERACT INFORMALLY WITH A 'KEY REFERENCE' IN YOUR AREA

GIVING YOU THE CHANCE TO INTERACT OUTSIDE 'THE NORMAL UNIVERSITY STRUCTURE'

**FOR MENTORS:**

SHARE EXPERTISE

SHARE IDEAS ABOUT NEW RESEARCH

PROVIDE INSIGHTS FROM YOUR EXPERIENCE

eas european aquaculture society

**SIGN UP!**

To apply send an e-mail to: ana@aquaeas.eu

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JOIN US IN ITALY FOR AQUACULTURE EUROPE 2022

# INNOVATIVE SOLUTIONS IN A CHANGING WORLD

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