# Summary Report

# Balanced Diversity

## in Aquaculture Development

aquaculture europe 23

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**This document provides information on the AE2023 scientific conference, with a compilation of reports received by the session chairs of the parallel sessions, presented in alphabetical order. Only simple editing has been made by the EAS secretariat.**

The winners of the AE2023 Poster Awards, as designated by the Session Chairs and Programme co-chairs, as well as the EAS Student Group Ibrahim Okumus Award are also presented.

*Compiled by the European Aquaculture Society secretariat. November 2023*

***Photos by Ana Viskovic***

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# Acknowledgements and AE2023 Organising Committees

The successful coordination of our Aquaculture Europe events relies heavily on the dedicated efforts of our organizing committees, program co-chairs, and session chairs. We extend our heartfelt appreciation for the substantial time and energy contributed by these volunteers to ensure the success of the meeting.

**AE2023 Steering Committee**

Chair: Laszlo Varadi (HUNATiP, Hungary) Members: Kathrin Steinberg (ASC, Germany), Zdenek Adamek (Uni South Bohemia, Czech Republic), Melanie Haslauer (Chamber of Agriculture of Lower Austria) and Birgit Schmidt-Puckhaber (German Agricultural Society)

**AE2023 Programme Co-chairs**

Bela Urbanyi (University of Agriculture and Life Sciences, MATE, Hungary) and Nikos Papandroulakis (HCMR, Greece)

**AE2023 Local Organising Committee (LOC)**

Bela Halasi-Kovacs (MATE, Hungary), Akos Horvath (MATE, Hungary), Oliver Hochwartner (Freelance vet, Austria), Thomas Friedrich (Institute of Hydrobiology and Aquatic Ecosystem Management, Austria) and Emese Bekefi (MATE HAKI, Hungary)

**Our team is profoundly thankful for the invaluable assistance provided by our outstanding group of student helpers!**

## Overview and Plenary Sessions

Organised by the European Aquaculture Society (EAS) and supported by AE2023 Gold Sponsor Biomar, session sponsors DSM-Firmenich, Meeting Destination Vienna, as well as associate and media partners, AE2023 was held at the Messe Wien Congress Centre, Vienna, Austria.

AE2023 attracted a total participation of 2293 from an impressive 80 countries. Of the full conference delegates, 378 were students. The trade show presented products and services from 164 exhibitors. The scientific conference received 1009 abstracts, resulting in 545 oral and 463 e-poster presentations in the 52 sessions of the event.
AE2023 also included the Industry Forum, Innovation Forum and several workshops specifically targeted towards industry.

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The event was opened with welcome addresses from AE2023 Steering Committee chair Laszlo Varadi, and EAS President Bente Torstensen.

Centered around the theme “Balanced Diversity in Aquaculture Development” the event featured three plenary sessions paving the way for subsequent parallel sessions, made up of oral and poster presentations. Steering this complex process, AE2023 program co-chairs Bela Urbanyi (University of Agriculture and Life Sciences, MATE, Hungary) and Nikos Papandroulakis (HCMR, Greece) skillfully managed session chairs facing the challenging task of selecting abstracts given their substantial number.

The first day kicked off with a fascinating opening plenary presentation entitled **“Balanced diversity and the responsible use of global resources to produce healthy food”** given by Professor Dr. József Popp, Janos Neumann University.

The world food system is facing a decrease in the diversity of crops and animal breeds. The threat to agrobiodiversity and the trend towards homogenisation reduces the sector's ability to overcome challenges such as climate change or diseases. In contrast to agriculture, aquaculture is expanding in terms of new areas and species as well as diversifying aquatic resources, species, products, systems and technologies. The aquaculture sector currently provides more opportunities for efficient transformation of agriculture and fisheries resources for human protein consumption than much of the terrestrial livestock sector.

At the global scale, increasing the diversity of food production activities, the aquaculture sector can improve the resilience of the world’s food system. Aquaculture both in marine and freshwater has new opportunities to contribute to the sustainable growth and improved resiliency of world food systems. Recent results of research and innovation provide a solid basis for the responsible and balanced use of diverse resources.

Despite the relatively low production volume of the freshwater aquaculture sector in Central and Eastern Europe, there is a remarkable trend towards diversification in the use of resources, production of new species and fish products, application of innovative systems and technologies. Even if traditional pond fish production remains an important part of the aquaculture sector in this region, there is a trend towards the wider application of combined intensive-extensive systems,

freshwater IMTA systems, recirculating aquaculture systems (RAS). Most of these systems and technologies are good examples how to utilize the opportunities that are provided by diversification and circular economy.

## The AE2023 Student Spotlight Award

Once again, the event opened with the Student Spotlight Award that allows three student finalists to pitch their work to the plenary audience, who then vote for the winner.

This award showcases the capabilities of emerging researchers and he three finalists were selected from the 143 abstracts that were received. The EAS Board of Directors, Lenka Kajgrova, Ana Viskovic pre-scored the abstracts and the three finalists were then selected by the AE2023 Programme Co-chairs Bela Urbanyi and Nikos Papandroulakis.

The winners of this selection procedure and taking part in the Spotlight Award 2023 finals were:

| **Ricardo Domingo Bréton**<br>Institute of Aquaculture Torre de la Sal (IATS, CSIC), Castellón, Spain | **Marina Pampín Iglesias**<br>Universidade de Santiago de Compostela, Lugo, Spain | **Daniela Resende**<br>Universidade do Porto, Portugal |
|---|---|---|
|  |  |  |
| GILTHEAD SEA BREAM MICROBIOTA SHIFTS ASSOCIATED WITH THERMAL STRESS AND DIETARY INTERVENTION DURING A RECORD HEAT SUMMER | IDENTIFICATION AND VALIDATION OF GENETIC MARKERS ASSOCIATED WITH *Marteilia cochillia* RESILIENCE IN THE COMMON COCKLE (*Cerastoderma edule*) | DIETARY INCLUSION OF SARDINE COOKING WATERS: IMPACT ON APPETITE REGULATION, GROWTH AND SENSORY PROPERTIES OF EUROPEAN SEABASS |

The three finalists received a €300 cash contribution towards travel and subsistence costs to attend the event and a free registration. They were provided with guidelines to prepare their pitch. Each presentation was just 3 minutes and in front of the biggest audience they had ever seen!

Out of an estimated 850 individuals present, 400 utilized menti.com to vote for their preferred pitch, ultimately declaring Ricardo Domingo Bréton as the winner. Mariana Fereira, serving as the Student Representative on the EAS Board of Directors, hosted the award and EAS President Bente Torstensen presented Ricardo with an additional €300 as his prize.



**We eagerly anticipate organizing the EAS Student Spotlight Award next year during AQUA2024 in Copenhagen, Denmark!**

The plenary session on Day 2 addressed **"Breeding for Resilience – Are we ready?",** and was a combined presentation by Antti Kause, Principal Scientist at the Natural Resources Institute (LUKE) in Finland and Morten Rye, Director, External Services and Global Strategies at Benchmark Norway.

We have seen significant impact of breeding programme for the main culture European species over recent years and we have new, better and faster tools to maximise the success of those programmes. But the changes that we face in the short and medium term might mean that our progress is overtaken by those changes. Are the current strains resilient enough? Do we have the necessary tools to support selection goals? What are the risks and opportunities in selecting new strains?


The final plenary presentation was given by Lissy Smit , the CEO of Netherlands-based Aqua-Spark and addressing the subject of **"Moving aquaculture to more sustainable, healthier and affordable production, an investor viewpoint."**

When Aqua-Spark was launched in 2015, it was the first investment fund dedicated to sustainable aquaculture. Aqua-Spark was founded on the believe that sustainable aquaculture is one of the long-term solutions to restore Ocean health, that we do not need to rely on wild resources or extensive antibiotics and chemicals usage to keep fish alive. Often, we invest in solutions before demand is there. We create demand by proving that sustainable practices can be achieved by developing and scaling novel and innovative solutions. Many of our investments have been developed in an academic setting and by working with our network of experts we aim to support

these ideas and innovations by proving capital to make them accessible and affordable. Sharing examples of our investment portfolio on how to bring solutions from great ideas and innovations to wide industry adoption.




The AE2023 trade show was also extremely well attended, with 164 booths for exhibitors showing their latest products and services.

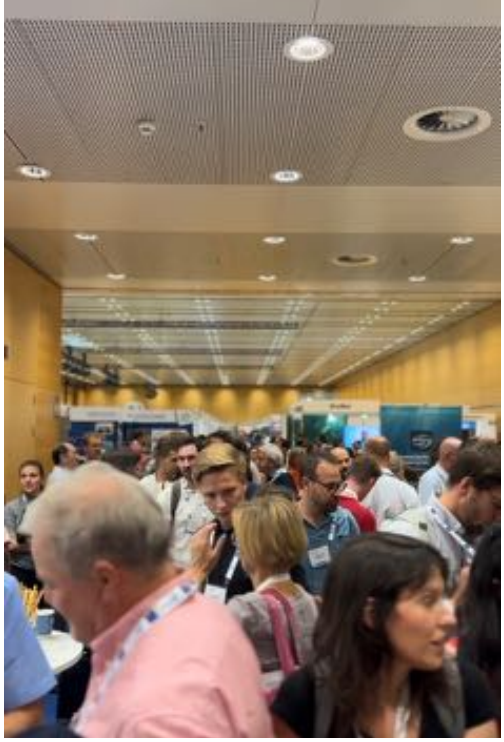

One of the features of the AE events is the inclusion of "special sessions" that are targeted towards an industry audience.

At AE2023, these included:

- Innovations in Modern Fish Production, organised by the Polish Sturgeon Fish Producers Association
- A workshop "Light and Fish", organised by MATE and Eurofish
- The EU BlueInvest Thematic Workshop on Aquaculture, organised by price Waterhouse Coopers
- The EUROSHRIMP FORUM, organised by the Alfred Wenger Institute
- The AE2023 INDUSTRY FORUM
- The AE2023 INNOVATION FORUM, organised by EAS and EATiP.

Other workshops, project meetings and business meetings complemented the AE 2023 programme.

**The very high number of abstracts submitted, the overwhelming attendance from so many countries and the number of requests for special sessions and project dissemination events once again confirmed the status of Aquaculture Europe as being THE European aquaculture event.**

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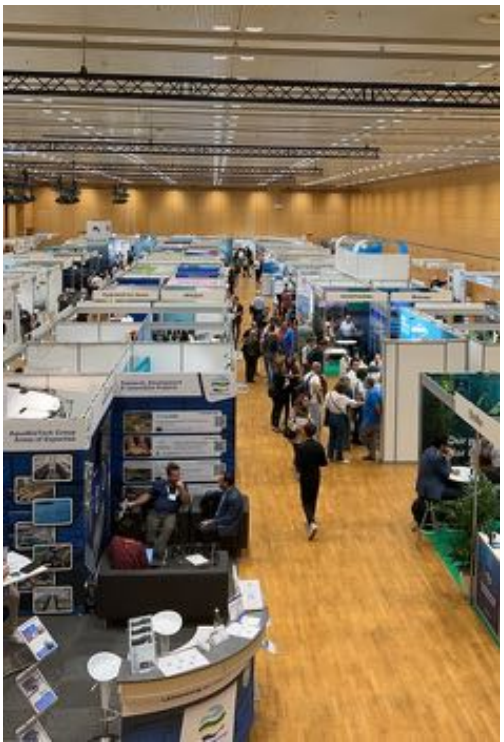


# Parallel session summaries

The following session reports were provided by the session chairs, with only minor editing made by the EAS secretariat. **They appear here in the alphabetical order of the AE2023** Unfortunately, one or two sessions are missing, with no report having been provided.

## Animal Testing – The 3Rs – Replace, Reduce and Refine

**Chairs: Bianka Grunow (Forschungsinstitut für Nutztierbiologie, Dummerstorf, Germany), and Zsolt Csenki-Bakos (UNI-MATE, Hungary)**

The session went well overall and had good attendance, even on the last day in the afternoon - at the time when many are already departing. Compared to the previous year, there were more presentations and especially the number of talks about cell culture was increasing.
Nonetheless, I have some suggestions for improvements for the next year:

1. Change of  Session name: The current name (“Animal testing”) is misleading, it would be sensible to consider changing it to better reflect the session's focus.

2. Thematic Division of "Welfare": Currently there is a lot of overlap with the Welfare session. The idea of dividing the Welfare session thematically to create a clearer separation from the 3Rs session is worth considering and would provide better orientation for participants.

3. Specific focus for the 3R Session: If the 3Rs session focused exclusively on alternative methods/replacements, this could improve the clarity and focus of the session and would allow for better separation from the Session “Welfare”. This is particularly important as fish cell cultures in particular are still very much neglected at the EAS.

4. Promotion of fish cell cultures: it is essential to emphasize the importance of fish cell cultures in fish and aquaculture research. These technologies have a proven track record in other research areas and are already making valuable contributions in fish virology, pathology, and the study of climate change and microbiota, etc.. It is unfortunate to hear that (at least one other) session chairs still do not accept cell cultures and tell presenters so directly! The fact is, fish cells are becoming more and more popular and used in research and surely, as already in veterinary medicine and human medicine, cell cultures will form the basis in the near/distant future before in vivo studies are allowed to perform. It is important to promote scientific diversity and different methods to advance research.

From the organizers, I would hope for the 3R session,

1. to rename it to “3R-Replacement-Alternative Methods”, there should be a greater emphasis on alternative methods, spanning from cell culture techniques to new technological advancements.
2. to no longer be scheduled for the last afternoon of the event but rather on a different day. This change would give the session more prominence.

## Aquaponics and urban farming

**Chairs: Sara Pinho (IGZ, Germany) and Hendrik Monsees (IGZ, Germany)**

The afternoon session was attended by approximately 50 to 60 people. All presentations were engaging and generated questions from an audience that exhibited a strong interest and knowledge in the subject matter.

The session included a diverse range of presentations, each shedding light on different areas of aquaponics and urban farming. The range of talks, originating from numerous institutions and research groups across the EU, the UK, the USA, and even Australia, indicates that aquaponics and urban farming are becoming increasingly widespread, with many aspects requiring further investigation. Several talks were delivered by PhD students, as well as by more experienced researchers and speakers. These presentations covered critical areas, including the chemical boundaries of aquaponics to optimise nutrient supply, project presentation on aquaculture development in East Africa, the design of RAS and aquaponics systems, urban bivalve production, innovative insect-based fish feed, and fungicides for aquaponics. Presentations also included the effect of the fish tank's history on the water microbial community, the significance of understanding hourly-based fish ammonia excretion in aquaponics, and an outstanding presentation explored the sensory characteristics of aquaponics-grown kale. Additionally, in response to one presenter's absence, two poster presenters stepped in to share their insights, with one focusing on Circular fish feed in aquaponics and the other providing an overview of Aquaponics projects at CSIRO-Australia.

During the session, participants engaged in an exciting discussion regarding the long-term viability of aquaponics systems. This discussion questioned whether these systems are merely conceptual for future food production or represent a viable current solution. Many presentations converged on this discussion, and the audience actively contributed to it, reflecting the importance of addressing economic and practical challenges and gaps in the field. Additionally, the bottlenecks and barriers for a broader commercial application of this promising technology were discussed as well as potential solutions.

The session highlighted several future priorities for the aquaponics and urban farming sector. These priorities encompass economic analyses to ensure the sustainability of aquaponics systems, the creation of resilient business models to facilitate industry expansion, and the exploration of diverse contexts for integrating aquaponics, particularly within urban settings. Finally, the needs for further standardisation and research in terms of

food safety, production protocols as well as the need for specific subsidies were discussed and highlighted.

## Education, training and capacity building

**Chairs: Béla Urbányi (UNI-MATE, Hungary) and Philip James (NOFIMA, Norway)**

The theme of the session is a priority for both EU and European marine and freshwater aquaculture. Serious labour and skills shortages are likely to develop in some sectors over the next 10 years, and therefore joint thinking, transfer of best practices, knowledge- and technology transfer and the resulting cooperation will be essential in the future.
The session included 7 oral presentations. Due to time constraints, the e-poster presentation was not realised.

Khademi-Vidra and colleagues reported on the state of secondary school biology and natural science education in Hungary. An intensive dialogue has been initiated with high schools with a special focus on these subjects, with the aim of promoting the aquaculture sector by organising special exercises for secondary school students who study biology and natural science in extra lessons. In parallel with the students, work will also begin to develop the aquaculture knowledge of secondary school biology teachers through the organisation of study trips and the active involvement of teachers.

Professor Barry Costa - Pierce gave a presentation on alternative ways to develop RAS systems. He stressed that the production of fish alone no longer meets consumer demands. What is needed is fish farms with near-zero emissions, which can be achieved through the use of captive power generation, recycling of waste materials and integration of aquaponics. Tourism must be integrated into the everyday aquaculture production technology so that consumers or potential consumers can see for themselves the sustainability and safety of the production environment. In addition, learning and training opportunities should be provided for all age groups.

Professor Philip James shared with the audience the experience gained from the AquaVitae project in knowledge management and capacity building during the project's lifetime. The project involved several new marine organisations in aquaculture production, whose production and feed technology required new knowledge to be acquired and shared between the partners. This was achieved through online courses, focusing on the transfer of deep practical knowledge. The researcher exchange programme and the regular webinars on a specific problem area helped to support the early career researchers and to acquire knowledge. In addition, the project has also developed a playgame to present the essential knowledge and information of aquaculture in a playful and accessible way, the final version of which is now available.

Hendrik Monsees from Germany gave a presentation and practical demonstration on the potential of virtual reality (VR), an innovation developed by a German company. VR has the potential to provide solutions in areas that are often cumbersome and difficult to learn and acquire practical skills. It can be used in aquaculture education at all levels (primary, secondary

and tertiary), where the appropriate knowledge and skills for each level need to be developed and can be supported by VR tools and visuals. In addition to assisting traditional education, further training of professionals, aquaculture areas requiring specific knowledge (e.g. compliance and adherence to processor hygiene) are all already referenced and use is limited only by capacity.

Professor Béla Urbányi gave a presentation on the educational problems, successes and future plans of the Hungarian aquaculture sector. The current situation in primary and secondary education is critical: the aquaculture sector is not able to compete with other agricultural fields and is not popular among young people. In Hungary, there is no problem at the university (tertiary) level and adult education is successfully continuing. A key task for the sector is to develop, in cooperation with the angling sector, a common aquaculture-fisheries training strategy, which will build and implement the plan in measurable and accountable milestones, step by step, from primary schools to higher education institutions.

Lola Toomey, representing the Italian foundation COISPA, gave a presentation on the situation and future prospects of organic products in aquaculture. The EU aquaculture sector currently accounts for 9.1% of organic products, far below the levels in other animal breeding sectors. The perception of organic products in marine and freshwater aquaculture countries and among consumers of these products is very different, which is also a cause for reflection. The promotion of organic products to potential consumers, the organisation, monitoring and follow-up of educational and knowledge transfer campaigns are essential to increase the consumption and trade of environmentally friendly and food-safe organic products in the EU. Researcher Kristine Vedal StØrkersen gave an update on the Norwegian salmon production sector, focusing on biosecurity, problem management and barriers to knowledge transfer. Based on dozens of interviews, it was found that there are serious doubts about the applicability of biosecurity in the most advanced salmon production in aquaculture. Communication, sharing knowledge and experience, and bridging the knowledge gap can be the solution to overcome these barriers, starting in schools and continuing throughout life. In the transfer of knowledge and know-how, a key task is to pass on new knowledge to policy-makers, because regulations based on unfounded information often result in over-regulated systems, which in practice creates new problems.

Overall summary: the speakers gave very good presentations, their selection was justified, they were well prepared in their respective fields and all of them contained a lot of new information. In the future, the legitimacy of this section (topic) is unquestionable.

## Genomics/Post-genomics/epigentics

**Chairs: Delphine Lallias (INRAE, France) and Diego Robledo (The Roslin Institute, Scotland)**

The session ran for 1.5 days, covering a large diversity of topics. However, each half day was focused on one thematic issue, and comprised of one longer talk (30 minutes) to introduce the topic and a number of 15-minute talks around the same topic.

The first half-day was focused on the functional annotation of fish genomes. The session was dominated by the results of the European project AQUA-FAANG, with 5 out of 6 oral presentations being a direct product of this project, and presenting the functional annotation of the genomes of Atlantic salmon, rainbow trout, gilthead seabream and European seabass. Additionally, the annotation of the turbot genome was presented as a poster. In summary, genome annotations derived from RNA-seq, ATAC-seq and ChIP-seq were presented for the first time for the five main fish aquaculture species in Europe. These results clearly represent a huge concerted effort by multiple European institutions. The optimization of the different techniques in the various species is a massive contribution to the research community, and the data produced will surely feed into other research during the next decades. Exploitation of these datasets is yet in its infancy, and AQUA-FAANG results are still slim in biological relevance, so it is likely that communications exploiting the results of this project will be presented in various EAS conferences during the next years.

The second half-day was more diverse in terms of topics covered and was comprised of 11 talks. It started with 5 talks on epigenetics, *i.e.* how different stimuli (such as nutrition or temperature), through the establishment of epigenetics marks, can impact fish physiology later in life. This is an important topic in aquaculture research that can have practical implications, as such phenotypic programming strategies represent a lever to adjust fish phenotypes to their environment. It is expected that this field will expand in the future. Focus should be on: i) diversifying the environmental stimuli studied; ii) addressing the interactions between genetics, epigenetics and the environment; iii) combining epigenetic and transcriptomic studies. The rest of the talks showed the diversity of topics addressed in present aquaculture genomics. A high-quality genome assembly of the African catfish was presented. Two genome-wide association studies (GWAS) for disease resistance in two main European aquaculture species (rainbow trout and European seabass) were also presented, showing the benefits of using either high-density genotypes or transcriptomic data to identify candidate genes underlying the traits of interest. With the decreasing costs of sequencing technologies, it is anticipated that more high-quality fish genomes will be produced and that GWAS, by combining complex datasets, will lead to identification of candidate genes that will need to be validated. The last three talks of this second subsection were about methodological developments.

The last half-day of the session focused on transcriptomics. Two main key messages were clear: i) the first studies using single-cell RNA sequencing technologies are appearing in aquaculture species. This technology offers a new dimension to transcriptomic studies, enabling the identification of cell types and the acquisition of biological knowledge about the studied processes at completely new levels; ii) the main interest of genomics research in aquaculture is still to tackle infectious diseases, with 5 out of 6 talks being focused on studying different diseases in Atlantic salmon, Nile tilapia, whiteleg shrimp and Senegalese sole. This trend has been obvious for quite a few years, a reflection of the lack of success of the industry in dealing with infectious diseases. It will be interesting to see whether the new technologies and approaches (functional genome annotation, single-cell sequencing) lead to answers in this area or whether infectious diseases will continue to be the major topic of genomics talks during the next years.

## Health Management – Gut Health session

**Chair: Ana Couto (Faculty of Science, University of Porto, Portugal)**

The gut health topic focused mostly on functional ingredients to improve gut health, using a range of approaches and analytical methodologies. The present report focuses on state of the art considerations, trends and gaps. The report includes considerations on oral presentations and posters.

The goal of gut health seems to be addressed mainly by dietary supplementation with functional ingredients of several origins. Namely, 1) Probiotics, such as *Lactobacillus* sp. or a microbial consortium of marine origin; 2) yeast, partitioned or whole and 3) algae, macro- and microalgae, supplemented to the diets whole or partitioned (e.g., extracts, purified compounds: laminarin, fucoidan). Results from commercial products (e.g., Sanacore ®, Balangut®) were also presented.

The procedures to assess gut health are diverse and address the concept of gut health from different perspectives. Immune response and gut microbiota profiling seem to be the most frequently used ways of evaluating gut health. Several in vitro assays were also presented, mainly to quantify permeability and immune response / inflammation to feed additives, which seems to show an increased awareness to the 3 R's policy, particularly when screening several functional additives. Less common, are approaches involving histological or enzymatic techniques.

The discussion throughout the session was not the most live one, because there were few people in the room, but also due to several presenters not answering questions because it was protected information. From an academic perspective, these discussions are sterile, turn these experiments irreproducible and impair science moving forward.

Overall, there is a clear bet on improving gut health in aquaculture fish, starting at early stages. The functional ingredients are a clear approach to overcome the issue of gut health and there are several people working on developing new dietary formulas to a better nutritional and overall health of fish. A straightforward approach to evaluate gut health seems to be lacking, probably due to the definition being too wide. Nevertheless, gut health and functional ingredients are a hot topic in contemporary aquaculture research.

## Integrated Multitrohpic Aquaculture (IMTA)

**Chair: Pauline O'Donohoe (Marine Institute, Ireland) and Colin Hannon (Atlantic Technological University, Ireland)**

Integrated Multi-Trophic Aquaculture, although still in the pilot stage in Europe, is proving to be a production method of increasing interest in many jurisdictions. The interest from all aquaculture sectors, be it fresh water or marine, open or closed systems was reflected in the variety of presentations given and the attendance at this session. The session covered a broad range of challenges both for land based and sea based IMTA from Atlantic and European

countries. The standard of presentations was very high and the audience showed their interest with interesting questions and interactions.

The first two presentations were from land based freshwater systems where data was used from fish production to model IMTA interactions. The topic was sufficiently covered, however there was uncertainty regarding the economic implications of the outputs of this type research showing that more work needs to be done in this area for it to translate to the aquaculture industry.

The utilisation of carbon and nitrogen including production methods for polychaetes in a laboratory scale setting was demonstrated in this study. The commercial uses of the outputs were quite clear and the potential for this type of remediation were set out.

The ASTRAL project showed the successful use of the macroalgae *Ulva* integrated into the South African abalone industry (Land based IMTA) over the past two decades. This presentation concluded that land-based, seaweed/invertebrate integrated aquaculture will continue to be developed as a successful example of marine IMTA in South Africa and around the world.

The AquaVitae project investigated the use of a mussel farm to assimilate waste from a nearby salmon farm in a sea based commercial IMTA setting in the Faroe Islands. This work demonstrated the potential for this type on IMTA by giving an insight into the water movement and hydrodynamic modeling that drives this interaction.

The microbiome of the bacterial assemblages from the hatchery to grow out on a commercial abalone farm in South Africa was presented by ASTRAL. This study shows the understanding of the bacterial dynamics, their sources of introduction and their roles at different abalone production stages in an integrated abalone-*Ulva* system. The introduction of *Ulva* into this type of production system shows a marked improvement in the performance of the system.

Food safety on bivalves and holothurians co-cultivated with fish in Mediterranean IMTA aquaculture investigated the production of Mediterranean mussel (*Mytilus galloprovincialis*), rayed pearl oyster (*Pinctada imbricata radiata*), and the sea cucumber (*Holothuria poli*). The results showed that these species are safe for human consumption, and IMTA aquaculture is a safe method to co-cultivate species from different trophic levels.

Sea urchin production from the ASTRAL project looked at their integration into land based IMTA in South Africa and the investigated of differing production methods. This industry driven research looked at the whole production cycle from spawning to grow out.

A land based IMTA system for the integration of bivalves, macroalgae and shrimp was presented. The research was conducted at a laboratory based scale and the presenter gave an overview of the interactions between the different species which demonstrated that RAS systems could be redesigned to use this selection of species to replace traditional biofilter units while producing food.

Sea based IMTA system for the production of bivalves in Greece, where areas were identified for IMTA and poly culture. The investigation showed positive results while safeguarding key species.

The BlueMarine Project was the focus of this presentation where the implementation of a land based IMTA system which includes both the hatchery through to the nursery production of macroalgae, bivalves and crustaceans was investigated.

Simulating nutrient fluxes and carbon budgets for aquaculture looked at mussel and rainbow trout farming in the Baltic Sea. This study modelled the nutrient fluxes of these species and showed that this type of approach would be a useful tool for developing IMTA.

The co-culture of sea cucumber with oysters in France in a sea based setting was discussed in this presentation. Novel cages were built to house each species at different levels or racks. Differences in growth rates were observed which were due to environmental factors and the species position in the rack/cage system.

Biofloc production was portrayed in this presentation showing the novel integration of *Ulva* into a biofloc system with intensive shrimp production. The research showed good results, the *Ulva* has the potential to change the dynamic with the biofloc system causing issues with sedimentation and water flow. This study was undertaken as part of the ASTRAL project.

The fianl presentaiton spoke of the use of carbon and nitrogen stable isotopes to elucidate trophic transfers between seabream, shrimp, clam and oyster reared in an integrated multitrophic aquaculture ponds. The aim of this study was to determine the food source transfers between the species oyster reared in IMTA ponds. The results showed that this type of IMTA production can prove successful with this compliment of species.

## Market & value chain economics

**Chair: Ragnar Tveterås (University of Stavanger, Norway)**

The topic market & value chain economics is huge, and the session covered a broad set of issues from farm to fork, with many different methodological approaches. I will only focus on some issues regarding the state of the art presented, gaps and/or future trends in the area and challenges/knowledge needs for the industry.

We had two presentation from incubators and accelerators, and afterwards there was a request from Ruth Gingold that EAS/WAS explore the possibility of a more focused session for these types of organizations/activities at the next conference. There is a potential for mutual learning and international netrwqork building between the organizations that provide these services to startup companies. I suggested to Ruth that establishment of a more dedicated session may depend on these organizations themselves being able to mobilize and have a dialogue with EAS/WAS.

The economics of fish diseases needs to be explored further, in particular, the market failure (or externalities) associated with diseases. In other words, when firms plan and undertake production activities they primarily care about their own biological and economic performance. Increased understanding of incentives related to biosecurity and fish health, and development of appropriate government regulations/instruments for mitigating the external costs on other farmers are needed. These should recognize the spatial transmission mechanisms for diseases, and farm location and timing of different production activities (fallowing etc.). Coordination of activities between farms that influence biosecurity and fish health is a key issue, but there remains a number of questions related to the design of regulatory instruments that can provide appropriate incentives and have significant economic effects.

The need for understanding and developing export distribution channels for aquaculture sectors with small firms (with limited internal marketing capacities) and small total volumes (leading to high distribution costs) remains an important issue. These are often characterized by low profitability margins, driven much by absence of economies of scale in several stages. If one recognizes that many aquaculture sectors will continue to have many small firms and low total production volumes, development of efficient mechanisms to increase knowledge about distribution channels and markets, contributing to an increase in sales value and reduction of distribution costs, deserve focus. Small-scale firms are often not able to build internal competencies on the downstream value chain, much due to high fixed costs associated with these types of competencies and activities. Exporters and importers can often play the intermediary role, and have these competencies, but farmers depend on a minimum level of knowledge and linkages to markets to understand their opportunities and barriers, and develop a sustainable strategy.

## Microbiome

**Chairs: Jaume Pérez Sánchez (CSIC, Spain) and Genciana Terova (University of Insubria, Italy)**

The microbiome session covered a broad range of farmed species (freshwater fish, marine fish and shrimp) and culture/production systems. The average quality rate of the presentations was quite high, contributing to reinforce the role of gut microbiota as a key point of multiple physiological functions such as nutrient absorption, energy metabolism, and immune and cognitive function as a promising way to improve host fitness in a context of a global change and limited fish meal and fish oil availability for new aquafeeds.

In total, 16 oral presentations were presented in one-day morning and afternoon session that highlighted a relatively high stability at a phylum level of gut, skin and gill microbiota composition. However, a high variability within and among species, and culture systems was found at lower taxonomic levels (family and genus). Therefore, a major challenge at short-term is to disclose the main source of the non-explained variability in microbiota composition (technological or biological) to make changes in microbiota markers as a routine and low cost-effective method to asses the health and welfare condition of aquatic farmed animals. It was pointed out that this will require gold standard procedures for a more accurate microbiota evaluation and taxa assignation through metabarcoding and/or shotgun approaches, depending of the scientific question and the required precision.

As a general issue, most of the speakers associated the increase of alpha-beta diversity indices with beneficial microbiota traits. However, both in sea bream and sea bass, selection for growth in the AQUAIMPACT EU project largely reduced the individual variability in gut microbiota composition. This microbiota feature was also concurrent with a higher gut microbiota stability in fish facing changes in diet composition, thanks to their improved metabolic plasticity not necessarily mediated by changes in gut microbiota composition. This assumption was supported by metagenomic and metatranscriptomic approaches, which highlighted the co-selection of productive aquaculture traits and gut microbiota signatures

according to the holobionte theory of evolution. In a practical sense, this reinforces the value of microbiota studies as a valuable tool for improving the future devolvement of a sustainable aquaculture industry.

Several speakers also addressed the effect of dietary non-starch polysaccharides and specific nutrients and additives on the gut microbiota of tilapia, sea bream, sea bass, trout and salmon. The effect of nutritional and environmental stressors upon the gut and skin microbiota of tilapia, carp or sea bream was also underscored, being noticeable the emerging role of the genus *Brevinema* as a reliable marker of heat stress in sea bream and perhaps other European farmed fish. The *Brevinema* study won the Student Spotlight Award of EAS 2023.

Major attention was also focused on microbiota dynamics in re-circulatory aquaculture systems (RAS), reflecting the interest of the industry for a better assessment of the interactions of farmed animals with their congeners and environment. This requires multi-holistic/omic approaches including matching-learning approaches. One proposed solution was based in Bayesian networks that served to recognize the bacteria taxa that act as parents within and among the established bacteria nodes. Altogether this is indicative of important advances in the field of aquaculture microbiota as part of a multi-trait phenotyping system to produce more robust and safety food aquatic products.

## Molluscs

**Chairs: Julie Maguire (Bantry Marine Research Station, Ireland) and Leire Arantzamendi (AZTI, Spain)**

The molluscs session covered many species of mussels, oysters, clams, cockles, limpets and octopus. Presentations included traditional topics of biotoxins, disease, genetics and aquaculture husbandry with many presentations focusing on extreme weather events including marine heat waves.

The session began with a presentation on the sustainable development of shellfish farming in Italy using a research-based approach. This was followed by six mussel presentations. These included how extreme weather events could make biotoxins and even greater threat to shellfish farming than they currently are. New sensors used for detecting tetrodotoxin in mussels was then presented. This was followed by a presentation on the green lipped mussel from New Zealand where spat is limited and sometimes wasted. However, practical solutions to solve the issues were proposed by the presenter. Another interesting presentation on green lipped mussels demonstrated how to put mussels to “sleep” during transport. The final presentations focused on how mussels are affected by prolonged heat waves (the byssus threads were particularly affected) and an assessment of new biodegrable ropes for use in mussel farming.

The session then moved to oysters where we first learned about spawning patterns in Sweden and how they can be predicted. This was followed by a presentation on the performance of oysters grown in subtidal and intertidal conditions in Scotland. We then

learned of the physiological effects of harmful algae on the Portuguese oyster. Then followed some presentations on shellfish disease; using transcriptomics to trace herpes virus, antibiotic resistance to *Splendidus* in the Eastern Adriatic and genetic markers associated with *Marteilia cochillia* resilience in the common cockle.

Two interesting French presentations then followed. The first showed us a diagnostic suitcase that contained all the necessary equipment and consumables (in miniature) in order to identify disease based on nanopore sequencing. This could be used by farmers in the field in the future. The second demonstrated a reference database and visualization platform for marine mollusc pathogen genomes that will soon be launched. This one stop shop will be very useful to all researchers who work on shellfish disease, particularly when outbreaks occur.

We then had two hatchery presentations. The first demonstrated how seawater conditioned with coralline algae induced limpets to settle. The second investigated the use of probiotics in the hatchery production of the manilla clam. Finally, we were treated to a presentation on octopus and the bioactive peptides they contain. We were left questioning if it would be possible to culture octopus…..?

## Nature-based Solutions and Eco-intensification in Aquaculture

**Chair: Dr. Koushik Roy (Faculty of Fisheries and Protection of Waters, Czechia)**

A total of seven oral presentations were presented. Three presentations were themed on aquaculture in marine or coastal aquatic systems, and four on fishponds.

### *Marine or coastal systems*

For example, Kamila Kulmambetova showed that for placing salmon net cages in bays, a traffic light system based on wind, water current direction, and bathymetry (continental slopes) could aid in deciding cage farm placements. To the extent that localized enrichment of nutrients, hypoxia, or algae could be avoided around farms.

Barry Antonio Costa-Pierce showed the diversity of locally farmed aquatic food species from the ocean across different trophic levels, offering a solid nexus of an environmentally friendly and nutritious aquatic food portfolio. But instead of valorizing such an opportunity, the developed economies are more focused on imported commodity consumerism, which is sustainable. Hence, it is missing out on opportunities to implement nature-based solutions in its regional blue food system.

Darien D. Mizuta showed that farming low at the trophic level in marine systems can also offer cash crops for aquaculture. An integrated mariculture (cage-based) of sea urchin, common periwinkle, and oysters in traditional bottom culture cages not only farm bivalves

but also avoid invasion of other biofouling agents by sea urchin and common periwinkle. Altogether, these three provide food and value-added by-products.

### *Fishpond/ inland shallow-lake systems*

Ferenc Levai showed the tremendous nature-based value that "pondscape (a consortium of ponds) based farms" could offer, from fish production (multi-cycle), storage of fish seed, fish gastronomy, and eco-tourism on-site to the general flood protection, ecosystem services, and biodiversity enhancement. In short, diversifying pond aquaculture's societal or environmental value and money, unlike other aquaculture farms.

Lenka Kajgrova showed the natural fluctuation of nitrogen and phosphorus in fishponds both organically (naturally) and under the influence of supplementary feeding (man-made changes). Temperate fishponds in central Europe tend to be phosphorus-limited for algae at the beginning and nitrogen-limited for algae by the end of the season under current management. Developing future pond-feeding solutions to balance and work around this natural imbalance is emphasized.

Bela Urbanyi showed the potential of combining cereal-based feeds and complete feeds in fishponds without destroying environmental or economic goals. In the multi-year production cycle of carp in fishponds, the cycle's beginning half (low biomass part) could be with complete feeds, and the cycle's last half (high biomass part) could be with cereals. This may check the lower use of complete feed and potentially reduce the production cycle to 2 years until marketable size. He further emphasized the divide due to a lack of research or prudent science to take a leap forward and adopt such a paradigm shift.

Koushik Roy showed how fish biomass in pond systems plays a big part in recycling nutrient (soluble reactive nitrogen and phosphorus) and supplying or fertilizing algae through their feeding and excretion actions. It was emphasized to join the ecological stoichiometry and fish nutritional bioenergetics fields with the nutritional ecology of the pond food web to optimize phosphorus and nitrogen trapping in fish biomass. Loopholes exist in fish biological systems, by some critical amino acid and energy molecules, that could be taken advantage of to eco-intensify pond fish production with a high nutrient use efficiency.

### *Conclusion*

All presentations had one observation in common. Outdoor aquacultures have tremendous potential for nature-based solutions and eco-intensification. But the sector's modernization or industrialization is either drifting away or overlooking these values. There is a need to counteract such a transition.

### *Recommendations*

- More and higher-quality research that deals with nature-based solutions or eco-intensification of aquaculture needs to be incentivized and emphasized.

- However, aquaculture communities are unaware of what can be called a nature-based solution in aquaculture. Opinions are all over the place. It must be first streamlined.
- IUCN has published a guideline on assessing different aquaculture production techniques, whether they are nature-based solutions (?). It is recommended that each system(s) of aquaculture does an independent assessment first to establish whether they presently qualify in the definition.
- Please consult the IUCN guideline at: https://www.iucn.org/news/marine-and-polar/202202/aquaculture-and-nature-based-solutions-new-report.

## Nutrition – Alternative Ingredients

**Chairs: Dan Leeming, Julieta Goenaga, Anne Kristine Grostøl Hansen, Keshuai LI, Stuart McMillan, Nick Wade & Mónica B Betancor**

The session «Alternative ingredients» attracted a great deal of attention which was evidenced by the large number of abstracts received. We will only focus on some issues regarding the state of the art presented, gaps and/or future trends in the area and challenges/knowledge needs for the industry.

The alternative ingredients discussed in the session can be listed into six categories: single cells (eg yeast, microalgae), seaweed, insects, terrestrial plants and others, representing the main alternatives being considered nowadays. The studies were focussed on a range of species highlighting the problematic issue of the high reliance on fish meal/oil. Curiously, only one study was focussed on larval stages, reflecting the lack of advancement in this area regarding live feeds substitution or usd of alternative ingredients during the first life stages. Despite the recent approval of an EPA and DHA GM-rapeseed oil in the USA and Norway, and the new bill recently approved in the British Parliament, only one talk tested the feasibility of including these ingredients in aquafeeds, probably reflecting that although the Technology Readiness Level (TRL) for this ingredient is high and legislation does not constrain their use, the industry might not be able to adopt them yet. In this line, precision fermentation, a technology that would allow to produce this essential fatty acids in several single cell sources, was not discussed. Nonetheless, the use of single cell proteins obtained by fermentation, seems to be a strong player within the list of alternative ingredients, either as a protein or an essential oil source. One limitation that prevents the adapation of these ingredients by the industry is scalability as well as price. Additionally, advancements also need to be made from the processing side of these ingredients in order to find drying procedures that are more effective from a $CO_2$ point of view so that they can still be considered sustainable. In line with sustainability, a focus should be made towards the adoption of by-products of different origin as alternative ingredients. These products sit very nicely within the circular economy/zero waste approach and were also discussed in the session.

As has been happening in recent years, many presentations dealt on the use of insect meal and oil as ingredients for a range of species. Although the production of insect meal has

grown exponentially in recent years, the scalability is still a constraint. It remains to be seen whether scalability is also a barrier for other novel ingredients presented during this session, including polycheate worms and tall oil fatty acids. Furthermore, although insect farming appears to satisfy the demands of the zero waste concept, a limitation is the permitted substrates, and the differing levels of stringency between countries, making it difficult to adopt this zero waste approach universally. Additionally, the variation in the chemical composition, and corresponding impact on nutritional value, of insect meal depending on the waste/feed stream, together with the high price, means the adoption of this ingredient is still anecdotical in aquafeeds.

A topic that was not discussed in detail (one presentation) was the examination of innovative organic ingredients. There is an appetite for organic aquaculture products around the world, and specifically in Europe with a recent HORIZON call focussed on the topic. Nonetheless, presently few ingredients are used in organic formulations. In the EU scenario this is mainly due to the impossibility to include synthetic amino acids into feeds which pushes it to use of high levels of fish meal and oil. Research into identification and nutritional characterization of organic sources, accompanied by digestibility studies is recommended. Indeed, something that was omitted from many of the presentations in the session were these aspects. Although these types of studies do not often appear attractive to researchers as it might not have a very high scientific impact, digestibility studies in particular are highly valid for feed formulators and producers and therefore carry a high industry and societal impact. Indeed, formulation is made based on digestible protein and assuming that this is equal to crude protein, and it will be risky to incorporate ingredients if the digestibility is unknown. Correspondingly, completing digestibility analyses could drive interest from industry and increase impact. This is in line with the wider goals for all alternative ingredients which is to increase sustainability, societal impact and public perception of our industry.

## Nutrition – Feed and feeding management

### Chairs: Astrid Buran Holan (ScaleAQ, Norway) and Bo-Groth Bendsen (DSM, Germany)

In this session day we had 20 presentations of 15 minutes. We organized the presentations in life stages. The morning session first covered research topics that concerned early life stages and feeding strategies, secondly raw materials and alternative ingredients. The afternoon session covered topics regarding nutrients and health, followed by feeding management including material flow analysis and water born feeding systems, and finally health additives including plant-based feed and additives. Many of the studies presented new results and were very interesting, judged by the response and questions from the audience.

The session emphasised that a there is quite a development going on in different life stages, however we saw the most interest and questions coming in the sessions for growout feed. Sustainability as a main driver for several of the presentations, where “less is more” was driving the high value feed presentations. As an example, the presentation under the subject “Unlocking the potential of the raw material (RM) basket from marine diets “was showing feed cost savings by LCA calculations when improving the RM digestibility when using

enzymes. The enzymes used in feed studies were phytases & proteases applied as post liquid application for extruded feed. Least cost formulations (LCF) were run and showed LCF savings of 11 USD/tonne in tilapia feeds and LCF saving of 15 USD/tonne shrimp feeds when using matrix values for the respective products. Studies performed with the newest generation of phytases were done in rainbow trout's, seabass, and tilapia. The matrix value that was applied in the LCA for tilapia feeds were from 6 USD/tonne, and for trout's an available phosphorous removal of 0,135%-0,190%. The data were solid, and we can ask why aquaculture is not using more enzymes, as terrestrials started to do 20 years ago.
Health and health additives were represented well, amongst others by a speaker that probably had the best presentation of the day with the subject disease mitigation with the focus on gram negative and gram positives bacteria. A relatively new terminology was mentioned; "quorum sensing" that illustrated that we could influence the communication between the bacteria and thereby limit the bacterial pathogen population growth in the gut. The sessions indicated a knowledge gap in risk assessment of feed when using more plant-based products. The afternoon session included a very interesting talk about waterborne feeding systems in a land-based farm for trout. In general, we could have had more presentation about feeding management as such, with the different applied systems or feeding strategies.

To be relevant for the industry, more research could benefit from having a more applied focus, where the experiments could be performed in semi-commercial farms or have up-scaling strategies as part of the study.

## Nutrition – Physiology and requirements

**Chairs: Johan Schrama (Wageningen University, The Netherlands) and Pauline Wischhusen (University of Stirling, Scotland)**

***Overview of the state-of-the-art presentations:*** New aquafeed formulations that rely on alternative ingredients have been major drivers in aquaculture nutrition research and continue to do. This has also been shown in the abstracts submitted to this year's Nutrition – Physiology and Requirements session, which covered a broad range of studies tackling major challenges within this area.

The morning session started on studies investigating the functionality of digestive enzymes in a variety of aquaculture species including new potential candidates for European fish farming. The evaluation of specific enzyme activities can provide valuable information on the digestive capacity and efficiency of a species to utilize feed components. In the long-term such data can contribute towards formulating diet and feeding protocols adapted to the fish metabolism. In this regard an important aspect is the inter-relationship between the nutritional and physiological characteristics of a fish and the environmental conditions covered in most studies. It became apparent that further research is required to better understand how feeding protocols might need to evolve under changing environmental conditions.

Another major topic within the session was the role of essential fatty acids within aquaculture nutrition. Dietary manipulations of specific fatty acids can have a major impact on animal growth, but also other factors such as the fish stress response and tissue fatty acid composition. The question was raised of how acute stressors can be alleviated through dietary fatty acid supply and what long-term effects can be expected by using specific dietary formulations at critical life stages. Therefore, the optimization of dietary fatty acid composition is of high interest to the industry to promote production performance as well as health and welfare of the fish.

A large proportion of the afternoon session was dedicated to the topic of fish mineral nutrition. Even today major gaps exist in our knowledge of requirements, physiological functions, and bioavailability of essential minerals in fish. Both mineral deficiencies and excess supply have been associated with diseases such as skeletal deformities, cataracts and nephrocalcinosis. The presenters showed that the availability and biological function of minerals can be restricted by nutrient-nutrient interactions. Ongoing changes in base feed formulation, including the introduction of alternative proteins, will therefore also affect the dietary mineral requirements in fish. Phosphorous uptake also shows nutrient-environment interactions. This is attributed to the ability of fish to acquire minerals through the gills from their surrounding water. The pressure of industry to switch to land-based farming systems that recirculate water and have specific physical-chemical properties increases the need for future studies in this area.

The session concluded with two presentations of applied basic research on cellular mechanisms involved in nutrient bioavailability. The studies showed that *in vitro* studies are a potent tool in future research of fish nutrition as a complement to the proof of concept in *in vivo* studies.

***Gaps in knowledge, future trends in field, industrial challenges & future required knowledge:***

These aspects were not addressed in the session or discussed, so the points below are more of a personal opinion:

- In the session very few papers addressed requirements. The number of species culture is increasing will only for limited amount of species requirement are published. The latest publication of NRC was in 2011. Very view studies after 2011 (and at current EAS) will provide data for a new NRC.
- Ingredient use in aquafeeds will diversify. Furthermore, ingredients used should not move to more co-products/waste streams to reduce feed-food competitions. This implies for industry that more low-quality ingredients are used less digestible/ higher content of carbohydrates. Carbohydrates are more than only starch. More fundamental/conceptual knowledge is required on impacts of low-quality ingredient on the (physiology) of fish (digestive physiology).
- Majority of nutritional (incl. requirement) studies are done with small fish < 40g in most species. But the majority feed (>90%) is consumed by fish over 40g. More studies should be done on “heavier” fish. E.g. in salmon above 1kg.
- Fish are cultured in different types of culture systems (pond, raceways, cages &RAS). More attention should be paid to the impact of culture systems on nutritional requirements/fish physiology. In other words, is a balanced diet for fish dependent

on culture system? some papers addressed this aspect e.g. regarding P uptake from water in RAS.

***Advice for future meetings:***

E-posters (like traditional posters) often do not get the attention they should get. Especially for young scientists (PhDs) that are not awarded with a oral presentation, the scientific exposure is important. For giving PhDs an opportunity, we gave all PhDs the possibility to give a 1-2min pitch about their poster with one question (so max 2 min per eposter). Such an approach might be made for all sessions.

## Offshore and multi-use

**Chairs: Annelies Declercq (Ghent University, Belgium) and Margriet Drouillon (Ghent University, Belgium),**

Trine Thorvaldsen:

This study examines the evolving landscape of salmon farming in Norway, which has historically relied on open sea-based cages but is now witnessing the emergence of new production systems. These developments have prompted a reevaluation of the regulatory framework. The research focuses on how operational risks are managed in the context of innovation processes related to development licenses. While the criteria for these licenses address certain risks such as salmon lice and waste, they omit considerations of occupational health and safety. The study's findings reveal that applicants utilized risk assessments to identify operational risks, with particular attention to fish welfare and personnel safety in offshore concepts. The interaction with regulators varied among applicants, some of whom consulted authorities regarding risk management and regulations for work hours. It is emphasized that while new technologies can mitigate certain risks, they may also introduce new ones, necessitating a comprehensive approach to risk management throughout the innovation process. Additionally, the government is working on new occupational health and safety regulations applicable to offshore aquaculture, set to be finalized in 2023. This research underscores the importance of addressing operational risks in tandem with technological innovation to ensure safe and compliant operations in the evolving salmon farming industry.

Frode Oppedal:

This presentation explores the prospects of offshore Atlantic salmon farming and the biological challenges associated with it. While Norway is moving toward offshore farming with new regulations and technologies, questions arise regarding the salmon's adaptability and the sufficiency of our biological knowledge for successful offshore production. Recent findings reveal that Atlantic salmon possess remarkable swimming capabilities, even in fluctuating water speeds. Observations suggest that submerged farming technology with swim bladder filling mechanisms could be a viable offshore solution. However, the feasibility of large offshore cages and their potential impact on fish health, particularly regarding oxygen levels, remains a topic of debate.

Summary : depending on biological parameters measured, ideal sites and locations in the water column can be chosen. Submersed air bags could be an aid to use submersed systems

for fish and to give them opportunities to also be able to grow offshore at depth to avoid getting sea lice.

### Langley Gace:

In the realm of warm water aquaculture, the shift is evident from sheltered sites to land-based and open ocean production. The consensus within the industry is that for safe open ocean farming, equipment should be submerged to avoid surface wave and storm disturbances. This approach not only reduces stakeholder conflicts but also leverages optimal growing temperatures, courtesy of seasonal thermoclines, and minimizes exposure to parasites and blooms commonly found at the surface. Innovasea has addressed the need for integrated submerged equipment and services over the past five years. Their cost-effective SeaProtean pen, featuring a variable buoyancy chamber, offers controlled ascent and descent, facilitating precise depth control for ideal growing conditions. The modular FlowFeeder ensures reliable, energy-efficient waterborne feeding, improving food conversion ratios and reducing environmental impact. Additionally, AI-powered solutions like aquaEnvironment and BiomassPro provide real-time monitoring of water conditions and fish stocks, enhancing production efficiency.

### Ajie Pribadi – UGent

In a full-scale offshore seaweed cultivation project in the Dutch part of the North Sea, the impact of environmental conditions (waves, currents, tides) and biomass on load measurements was studied. Tidal variations had the most significant effect on peak tension, especially during high and spring tides. High waves during harvesting had a lower impact. Biomass showed no clear influence on load. Low-frequency loads were the focus, and they correlated with tidal cycles. The study suggests that understanding tidal effects is crucial for optimizing offshore seaweed cultivation systems.

### Annelies Declercq – UGent :

This study focuses on the European flat oyster, Ostrea edulis, in the Belgian part of the North Sea (BPNS). Historically, flat oyster reefs disappeared due to overexploitation, habitat destruction, and diseases caused by Bonamia and Marteilia parasites. In a demonstration project within an offshore wind farm, they assessed the health of introduced flat oysters and their offspring and studied fouling biodiversity. None of the tested oysters were found to have Bonamia or Marteilia parasites, a promising sign for oyster restoration and cultivation. However, vigilance is needed for other potential diseases. The oyster habitat showed high species diversity, including reef-forming species and amphipods that may pose challenges to offshore aquaculture. This research is a crucial step towards the sustainable restoration and aquaculture of flat oysters in Belgium, offering cultural, ecological, and economic benefits.

### Bela Buck

The OLAMUR (Offshore Low-trophic Aquaculture in Multi-Use Scenario Realisation) project addresses global food security and ecosystem restoration by focusing on low trophic aquatic food production. It aims to demonstrate sustainable solutions for North and Baltic Seas, utilizing multi-use marine space, including offshore wind farm areas and integrated multi-trophic aquaculture (IMTA). OLAMUR integrates data, standards, and innovative governance into a digital MU-LTA farm service, supporting upscaling. Three pilot studies in Denmark, Estonia, and Germany test multi-use strategies combining seaweed, bivalves, and fish farms.

The project promotes science-policy-industry collaboration for sustainable and carbon-neutral marine space utilization, advancing European marine health and prosperity.
QUOTES: Nothing that we are doing, we can buy off-the-shelf. Weh ave tot hink about revolution when we go off the coast.

### Bela Buck

This research addresses the ambiguity surrounding the terms "offshore" and "open ocean" in the context of aquaculture, which have been used interchangeably without clear definitions. To reduce confusion, the ICES Working Group for Open Ocean Aquaculture (WGOOA) proposes a precise definition of "offshore" based on two metrics: distance from shore and exposure. This framework aims to provide a common understanding, assist regulators in site designation, help farmers assess development sites, guide equipment and vessel operations, and aid insurers and investors in assessing risk.
Neither the United Nations Convention on the Law of the Sea (UNCLOS) nor national aquaculture laws offer a precise definition of "offshore," necessitating a clear framework. The research quantifies distance from shore and exposure using indices that consider oceanic parameters. These metrics, seen as a range rather than a fixed threshold, facilitate the analysis of aquaculture sites and their socio-economic implications. Expanding aquaculture to "offshore" and "exposed" waters has advantages, including addressing public concerns about nearshore aquaculture.

### Per Arild Aland:

The trend in mariculture is shifting towards offshore locations, offering advantages like improved fish welfare, reduced conflicts in ocean space, and scalability without compromising sustainability. To ensure safety in offshore fish farming, uniformity, transparency, and predictability are essential for risk reduction. Key areas of concern include asset integrity, personnel safety, fish welfare, and fish escape prevention.
Asset integrity encompasses structural strength, stability, mooring, technical arrangements, and equipment reliability. Personnel safety involves emergency escape and fire safety measures, adhering to maritime codes like SOLAS. Fish welfare standards vary by local authorities, necessitating reliable monitoring technology for parameters like oxygen, temperature, salinity, and biomass levels. Fish control and escape prevention rely on the integrity of net systems, ropes, and fish transfer equipment.
These elements are interconnected and equally crucial for safe and sustainable offshore fish farming. Leveraging competence from the maritime industry, applying technical rules and classification requirements, and combining them with aquaculture-based standards can effectively reduce operational risks in offshore fish farming.

### Brecht Stechele - UGent

This research focuses on flat oyster habitat restoration and restorative aquaculture, highlighting the importance of oyster beds and reefs for ecosystem services and coastal economies. A population model coupled with a larvae dispersal model was employed to assess the suitability of locations in the English Channel and North Sea for these initiatives.
**Innovation and future:** The study identifies restoration hotspots in multiple regions, emphasizing the English Channel's high suitability for flat oyster restorative aquaculture. Offshore locations in the North Sea may require scaled-up efforts to boost population increases. To enhance flat oyster habitat restoration success, the authors recommend a basin-

wide coordinated restoration effort that fosters connectivity between natural oyster beds, restoration sites, oyster NID developments, and aquaculture sites.

### Per Aland - DNV

There is a significant potential to utilize competence from traditional offshore- and maritime industry to support operators of exposed fish farming units in design and tuning operational modes for efficient production. The industry is currently very much exploring possibilities and collecting experience from the various concepts being planned and put in operations. This learning journey is an important phase in the development of offshore fish farming to become a significant contributor in feeding future generations with sustainable and healthy marine proteins.

**Quote : „2050 is just around the corner, time is running quickly when you are having fun.“**

*Photo. Annelies Declercq*

## Optimising water and solids in RAS

### Chairs: Kevin Stiller (NOFIMA, Norway) and Elisavet Syropoulou (Wageningen University, The Netherlands)

The session covered various innovative aspects of recirculating aquaculture systems (RAS) with participants addressing several bottlenecks that challenge the sustainability of recirculating technology. In the morning, two speakers with an academic background talked about the importance of microbial control and proposed different disinfection methods as substitutes for ozone and UV application which are commonly used. Results from their pilot studies suggest that alternatives such as cold atmospheric plasma, pulsed electric fields and photo-oxidation can be successfully used for both biotic and abiotic decontamination. Along the same lines, captive deionization and chlorine-based treatment were both proposed as cost-effective technologies for the removal of nitrogen species and off-flavors. Considering the high cost operational of RAS, research findings presented hold promising solutions for cutting down the expenses of water treatment.

A topic which drew a lot of attention was ammonia removal. Even though nitrification is a standard practice for the conversion of ammonia to nitrate, its efficiency can still vary depending on the conditions of the biofiltration reactor. Industrial representatives had the opportunity to present us with results of tailored moving-bed reactors designed according to the system's ammonia load and protocols for a quick biofilter startup. Following up, several speakers addressed the complete elimination of nitrogen through the additional process of denitrification. They all acknowledged the need of an adequate supply of organic carbon to accommodate this heterotrophic bacterial process, as well as the high costs and challenges that relate to it. Several approaches for tackling this issue were presented here, starting with appropriate dosing based on sensors which detect intermediate products that indicate incomplete denitrification. Furthermore, denitrification efficiency was assessed under different external carbon sources and operational modes to identify optimal conditions. To weaken the dependency on external carbon supply, fish faeces were proposed as an alternative carbon source for denitrification. Results showed that even though efficiency varies with diet and thus faecal composition, faeces can substitute to a great extent for external carbon sources. In a similar context of eliminating two waste products in one go, biofloc growing on shrimp faecal waste was able to eliminate nitrogen but denitrified water was nonetheless considered unsafe for shrimp farming due to high mortalities. All research attempts hereby indicate the complexity of this biological process which is not yet mastered and warrants further investigation.

Solids removal was another aspect of water treatment which was touched upon. The interplay between feed and faecal waste production was addressed by a speaker that identified dietary starch as a determining factor for the accumulation of fin particles in a RAS growing rainbow trout. From a technical point of view, water-soluble polymers were proposed as flocculants that accommodate particle sedimentation. Exploratory studies on how to further utilize the collected sludge in a circular concept were presented during the afternoon session. Among them, anaerobic digestion of sludge for biogas production was a popular solution.

At the end of the day, two researchers discussed off-flavors, a problem that affects consumers' acceptability towards fish produced in RAS. A novel study that correlated off-flavors in fish fillets with sensory cues shed some light in the factors affecting product quality. An additional attempt to connect off-flavors with feed was made by a fellow researcher who suggested that feeding during depuration period eliminates dominant off-flavor compounds, contrarily to the common practice.

In summary, the session on "Optimizing water and Solids in RAS" addressed critical sustainability challenges. It highlighted novel microbial control methods, cost-effective water treatment options, and efficient ammonia removal techniques. Additional discussions revolved around solids removal, downstream utilization of sludge for energy production, and off-flavors, emphasizing the ongoing efforts to advance sustainable aquaculture practices.

## Other cultured species

### Chair: Philip James (NOFIMA, Norway)

The topic of 'Other Cultured Species' covers an enormous range of species that are not considered to be part of the existing aquaculture industry in Europe or worldwide.

This session covered macroalgae, molluscs, echinoderms, the use of low trophic species in aquaculture diets and various freshwater and marine finfish. The largest single section was on echinoderms where 4 papers were presented.

In general, this session was focused on the challenges faced to bring these species or topics to full industrial scale and create a viable industry. A good example of this is the sea urchin industry which is on the periphery of becoming a fully-fledged aquaculture industry and talks focused on larval settlement, new technology, sea urchin roe enhancement and sea urchin diets. There were a few finfish talks which varied in species from giant grouper to catfish. Again, these talks focused on the production bottlenecks for these species and ways to overcome them.

This session was varied and interesting and as the European aquaculture industry looks to expand and diversify some of the species presented in the session are likely to become more and more in focus.

## Percid fish culture

### Chair: Oleksandr Malinovskyi, Ph.D. (Faculty of Fisheries and Protection of Waters, Czechia)

The Percid Fish Culture session at Aquaculture Europe 2023 covered the latest advancements in percid aquaculture. Dedicated to diverse biotechnological aspects, the session dived into new areas such as polyculture in RAS, bone development, and fish behavior, collectively covering various stages of the production cycle.

The presentations were predominantly centered around pikeperch, the session provided a platform for research and breakthroughs in the species. The topics covered oocyte maturation, juvenile culture, and novel techniques and practices aiming for enhanced culture efficiency. These results have particular importance for the industry, as they have addressed a common bottlenecks within the pikeperch (mostly) production cycle.
The presentations demonstrated a particular focus on the feeding behaviour, including feeding habits, the impact of live prey feeding, and the evaluation of different feeding frequencies in RAS-based juvenile pikeperch aquaculture. These outputs contributed valuable knowledge on the potential modulation of fish behavior within a controlled environment.
From methodological validations for nutrient digestibility to cryopreservation as a tool for exploring paternal-effect genes, the session covered every stage of the percid production cycle. The variety in the approaches contributes to a better understanding of percid aquaculture.
While primarily focused on pikeperch, the session did not exclude other relevant species. Presentations on Yellow Perch and European perch added to the richness of the discussions, fostering a well-rounded exploration of percid aquaculture.

**Conclusion:**
The Percid Fish Culture session at Aquaculture Europe 2023 emerged as a dynamic platform, presenting the latest research and innovation in percid aquaculture. The diverse array of topics and species discussed reflects the vibrancy of aquaculture practices in different parts of Europe. It is evident that the variety of species represented, the methodologies used, and the issues addressed, were linked to the bottlenecks within industrial farming. It seems that the closer cooperation between industrial farming and scientific institutions has led to the unification of their problematics and interests, resulting in a higher share of applied research.

## Processing, co-products, packaging and value addition

**Chairs: Fanny Tsironi (Agricultural University of Athens, Greece) and Leonidas Papaharisis (Sustainability Director at Avramar, Greece)**

Approximately 80 participants attended the session, the key objective of which was to present the recent developments in research and practice of the post-harvesting activities in the aquaculture sector, including processing, packaging, side-stream valorization and design of value added products.

As a result, opinion exchange took place during the session and it was a good opportunity to deepen understanding and identifying problems in the production and cold chain of aquaculture products. The potential of using novel technologies at the post-harvesting stages and the requirements were discussed and the expectations of manufacturers and retailers were also considered.

## Reproduction and broodstock management

### Chairs: Constantinos Mylonas (Hellenic Centre for Marine Research) and Ákos Horváth (Hungarian University of Agriculture and Life Sciences)

The presentations addressing freshwater species could be sorted into the following main topics:

- Five presentations (Bernáth, Boryshpolets, Aquino, Nagy and Marinović) concentrated on **gamete quality** of various species mostly including sperm but also germline stem cells. Apparently, the interest in sperm management and cryopreservation techniques is still present. This is extended to various fish and shellfish species, including those of conservation interest.
- Two presentations (Stanivuk and Kitanović) focused on **pikeperch** as a model species, albeit, from a completely different perspective. While the first one discussed the effect of triploidization on gonad development, the second concentrated on in vitro maturation of post-vitellogenic oocytes.
- Two presentations (Uzochukwu and Molnár) on the effects of **various feeds** on gonadal development or fry growth using African catfish or chub (*Squalius cephalus*) as a model.
- One presentation (Rocha de Almeida) concentrated on the **maternal non-genetic inheritance** of strain-specific traits in rainbow trout larvae measured by survival parameters as well as response to bacterial challenge tests.
- Finally one presentation (Nejad) on the effects of **hormonal induction** (Ovulin) methods on stress parameters in the common carp.

The contributions addressing saltwater species were much fewer and focused on three species, the greater amberjack (*Seriola dumerili*), the meagre (*Argyrosomus regius*) and the Baltic cod (*Gadus morhua*).

- One presentation on greater amberjack (Fakriadis) reported on hormonal methods to enhance sperm production in F1 hatchery produced breeders, showing the hCG produced better results than GnRHa.
- Two presentations in meagre (Mylonas and Zupa) reported on the breeding behaviour in relation to sound production of this emerging species in Mediterranean aquaculture and the process of spermatogenesis using of recombinant gonadotropin hormones (rGtHs) in adults and pre-pubertal fish. As in other species, rGtHs constitute a very effective, though still expensive, method to control reproductive processes in fish!
- Very interesting results were presented regarding the spawning potential of cod in the Baltic Sea, which are genetically distinct from other populations, in relation to size and age.

The variety of topics in this session reflected the interest that is still expressed in fish and shellfish reproduction technologies. Reproduction and broodstock management is an important part of aquaculture and is expected to remain as such as the demand for high-quality seedstock is continuous. There was also an interesting presentation from a commercial participant (Innovasea), of a new software that was developed to help hatchery manager monitor individual breeders and their performance, which will be very useful for broodstock management.

## Selective breeding

### Chairs: Antti Kause (Natural Resources Institute, Finland) and Binyam Dagnachew (NOFIMA, Norway)

This session covered the recent advances in the breeding and genomic methods with focus on the potential applications used in breeding programmes. The two main topics were a) genome-wide association analysis (GWAS) to identify major genome regions that impact traits, and b) validation of prediction of genomic breeding values. Genomic selection, in which thousands of DNA markers are used to predict genomic breeding values of broodstock fish is common practice in Atlantic salmon, and becoming more common in the other species too.

In the session, results were presented for Pacific oyster, blue muscle, Atlantic salmon, rainbow trout, European sea bass, gilthead sea bream, Atlantic cod, senegalese sole, and turbot. The general trend in the GWAS studies was that large data sets, from multiple fish groups, are used to validate the results. This is useful because in this way we can identify permanent and consistent effects of genome regions on animal traits that can be specifically used in breeding programmes. Moreover, studies were presented that validated the superiority of using the genomic relationship matrix in genomic selection, rather than the use of the traditional pedigree based evaluation. There were also studies how additional information, including functional data or by combining pedigree and genomic information in a single-step genomic evaluation, can be used to increase accuracy of (genomic) breeding values. Single-step genomic evaluation is commonly used e.g. in cattle, and the presentation in #AE23 showed its benefit in rainbow trout.

The traits of focus were, in addition to production traits, product quality, maturity age, resistance to diseases, thermal response and gut microbiota.

The obvious next steps in which we have knowledge caps are studies which use multigenerational data to test novel statistical models and validation methods, and to model the mode of inheritance of traits in genomic selection. Multigenerational data sets allow to test the way genomic breeding values based on the current generation data are realized in the next, offspring generation.

## Welfare

### Chairs: Kathrin Steinberg (ASC, The Netherlands) and Timo Stadtlander (FiBL, Switzerland)

The continuously increased interest in welfare, not only for fish but also for crustaceans, has resulted in the need for a 1.5 day session on Welfare, plus another half day session on Welfare and Genetics as well as welfare related topics being present in many other sessions as a cross cutting theme.

In this 1.5 day session a total of 32 presentations were given covering a wide range of topics, species and regions.

The session was kicked off by a more general presentation from Joao Saraiva on the issues of farmed fish welfare under climate change, focussing especially on open systems exposed to weather and climate, such as pond and cage farming. Saraiva underlined the importance of increasing our knowledge on cultured finfish biology and their diversity, as well as on welfare science to help us cope with the inevitable consequences of climate change.

The following session focussed mainly on the farming of different salmonid species, different impacts on welfare ranging from temperature changes to vaccination and feeding, and ways to assess welfare, such as gene expressions or electrocardiography. The afternoon session was completed with three presentations looking at non-salmonid species, namely pacific white shrimp, red king crab and carp.

Day 2 of the welfare session was focussed more on mediterranean species and sedation as well as different stunning methods. The first two presentations by Ana Roque and Esther Hoyo-Alvarez provided a nice link to the discussions of the previous day on electrocardiography by looking at cardiac responses of seabass on different stressors. This was followed by presentations on sedatives, before Albin Gräns gave an overview presentation on prospects and pitfalls of using brain function in order to assess the effectiveness of stunning methods. His main finding, that many stunning methods previously thought to render fish unconscious may only cause paralysis was later repeated by several other presentations and sparked intensive discussions on stunning techniques as well as assessments of effectiveness. The session was wrapped up by three presentations looking at the potential effects and welfare implications of offshore aquaculture based on both the turbulent environment, as well as electromagnetic fields when farming close to offshore wind energy.

The session included a total of three poster reviews. The first one focussed on the three best graded posters in the welfare session on the development of less invasive methods for measurement of stress responses in seabass, the use of different matrices for oral vaccination in rainbow trout and on linking cardiac morphology and function in Atlantic salmon. Given the focus on mediterranean species on day 2, Claudia Millán and her colleagues were invited to present their poster on mediterranean aquaculture in the morning session, outlining the importance of scientific knowledge for mediterranean species, especially top predators like bluefin tuna and greater amberjack. The last poster session was used by the session chairs to point the attention of the audience to the very few posters looking at welfare in RAS, a topic that was only covered in one presentation in this 1.5 day session.

The session was well attended with several participants staying for the full 1.5 days. This allowed for good discussions that continued in smaller groups into the coffee breaks and happy hour.

## Workshop: Light and Fish

### Chairs: Béla Urbányi (MATE, Hungary) and Christian Philip Unmack (EUROFISH, Denmark)

The workshop was jointly organised by Eurofish (Denmark) and MATE (Hungary). The theme was light and its effects on physiology, growth, and nutrition on fish. The effect of light has gained increasing interest to both aquaculture researchers and developers in recent years. Light has have shown to have a significant effect on fish physiology. The wavelength, length of illumination, colour and intensity of light are all shown to affect the function of genes (genetics), growth (physiology), feed conversion and diet (nutrition), stress responses (immunology) and disease development (health) in fish. The effects are also depending on the species and the different ages/stages of the species. The above suggests that the subject is part of contemporary aquaculture and will become a major issue in the near future.
Six oral presentations were presented in the session, no e-poster presentations were made. The workshop was convened by Christian Philip Unmack (Eurofish) and co-chaired by Béla Urbányi (MATE).

Gyles Westcott presented "Light Support Systems, the new LSS: Considerations in advanced lighting and lighting control technology to reduce stress, improve welfare, and increase productivity". Basically, six parameters (oxygen-temperature-pH-water flow-waste formation-feeding) in the fish environment were investigated, which have a direct or indirect impact on the stress status of fish. Different lighting technologies can provide solutions to reduce and possibly eliminate these stress conditions.

Jurica Jug-Dujaković, Steven Van Gorder and Ana Gavrilović, in their presentation "Light conditions affecting the cultivation of Yellow Perch, *Perca flavescens*", reported practical experiences with yellow perch. They approached the problem from a market side, from an expectation side, and the cost side of production (culture) – the later, that was shown to be determined by the technology used to grow the fish. The most critical is larval rearing, because at this age the perch larvae are very sensitive to all environmental factors. The role of lighting, i.e., dark-light periods, wavelength of light used, etc., was shown to reduce the impact of stressors.

Balázs Kucska, Gabriella Stettner, Zoltán Horváth, Tamás Müller, Anna Siklósi, and Uros Ljubobratovic investigated the larval growth of perch in their presentation "Improving Intensive Larval Rearing of Pikeperch (*Sander lucioperca*) - Using Different Lighting". The basic factor was the 18 h light and 8 h dark period of illumination (light intensity: 70-450 Lux). The variable was the placement of the light panels, the light source was placed at different locations in the fish rearing ponds and the effects of this variable were investigated through the development of survival, swimming ability and cannibalism.

Kevin Nyabuto and his colleagues (József Horváth, Ádám Varga, Janka Páskai, Zita Rácz-Végh, Anita Rácz, Balázs Kovács, Julianna Kobolák, Péter Dániel, Béla Urbányi, Tamás Müller) investigated the effects of different wavelengths of light (red, green, blue and white) on larval individuals (“Effects of Different Light on Embryonic Development and Larval Rearing of African catfish (*Clarias gariepinus*)”). To do this, they developed a special fish-holding system

to detect the data as accurately as possible. They clearly found that different wavelengths of light have different effects on larval survival and growth.

Charline Pichon's presentation "The effect of light colour and intensity on the stress of the Pacific white shrimp (*Litopenaeus vannamei*)" examined the feeding behaviour of the shrimp and the physiological processes involved. The main objective was to identify whether light has any stress reducing effect during feeding, and a developed computer software was used to objectively test this.

Sebastian Marcus Strauch's presentation "Effects of Light on Atlantic Salmon (*Salmo salar*) approached the possible impacts of light from the physiological side, based on what was known about the effects of light in general. Photoreceptor function and stimulus uptake fundamentally determined the effects of light wavelength on fish, i.e. the 'right light' wavelength selection is the basis for a optimal (positive) smoltification stage of salmonid fish.

**General summary:** The speakers presented their research and development areas. From these presentations it can be concluded that the topicality of the subject is unique, there are many unexplored areas that still need to be investigated and analysed in terms of light vs. fish behaviour and physiology. However, research and development colleagues in the field have started to build a network that will form the basis for further collaborations.
Our own opinion: The unanimous opinion of the presenters and the workshop audience is that due to the unique character of the workshop, the importance of the topic, it is worth considering a session on this topic at the next EAS/WAS conference (August 2024, Copenhagen, Denmark).

## AE2023 Poster awards

At each Aquaculture Europe event, awards are presented for E-posters. In Vienna, these were the AE2023 Best Poster Award, the AE2023 Best Student Poster Award and the EAS_Student Group Ibrahim Okumus Award

For the two AE Awards, the posters of each session were assessed by the session chairs, and the best student poster and best poster for each session were attributed. These were then reviewed by the AE2023 Programme co-chairs to select the overall winners.

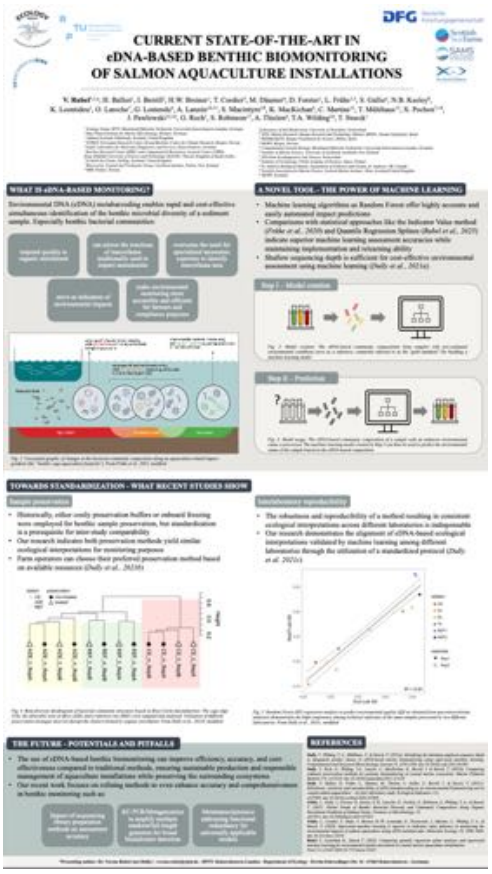
**Please click on the poster title to see the full PDF**

## AE2023 Best Poster Award

**In the main category, the "Best Poster Award" was awarded to Verena Rubel for "Current state-of-the-art in 'DNA-based benthic biomonitoring of salmon aquaculture facilities'".**

This study seeks to promote the use of bacteria-based eDNA as an effective tool for monitoring aquaculture, allowing species detection and monitoring of environmental impacts, facilitating sustainable management of aquaculture farms.


*Photo. Bente E. Torstensen, Verena Rubel, Nikos Papandroulakis, and Bela Urbanyi (from left to right)*



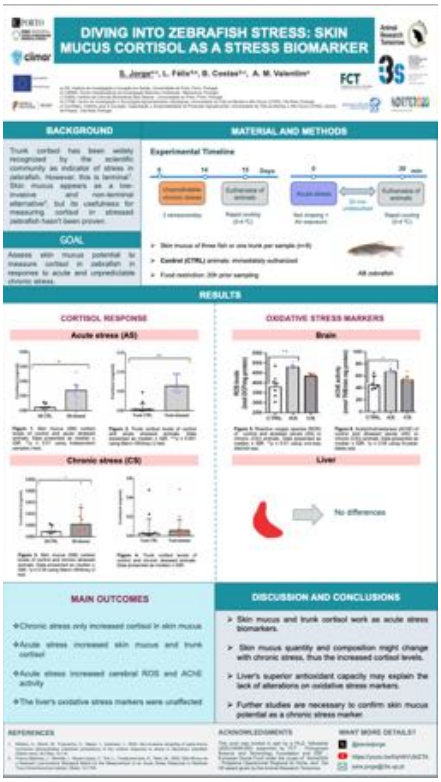

*Click on the e-poster to see the full size PDF*

## AE2023 Best Student Poster Award

**The “Best Student Poster Award” was awarded to Sara Jorge for her work titled "Diving into zebrafish stress: skin mucus cortisol as a stress biomarker."**

Her research focused on evaluating the ability of zebrafish skin mucus to quantify cortisol levels under acute and chronic stress, which may provide valuable insights into the well-being of these fish.


*Photo. Bente E. Torstensen, Sara Jorge, Nikos Papandroulakis, and Bela Urbanyi (from left to right)*

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## IBRAHIM OKUMUS AWARD

**“Ibrahim Okumus Award" was awarded to Kine Samset Hoem for her work entitled "Can stimulating mucus production reduce viral infection in farmed fish?".**

This award, chosen by young students attending the conference, aimed to analyze how viruses overcome the mucosal barriers of fish and how mucus can offer protection against these pathogens, both physically and chemically. This award was sponosored by Ethnical Seafood Research.

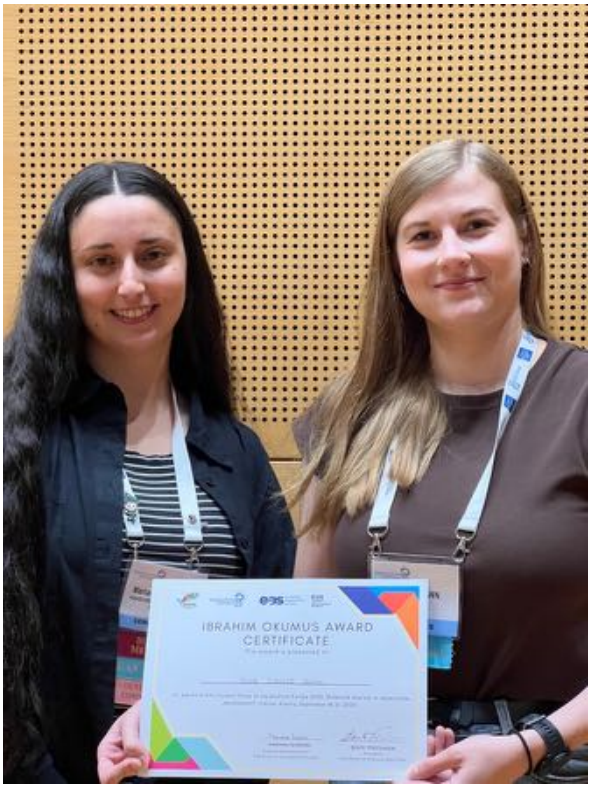
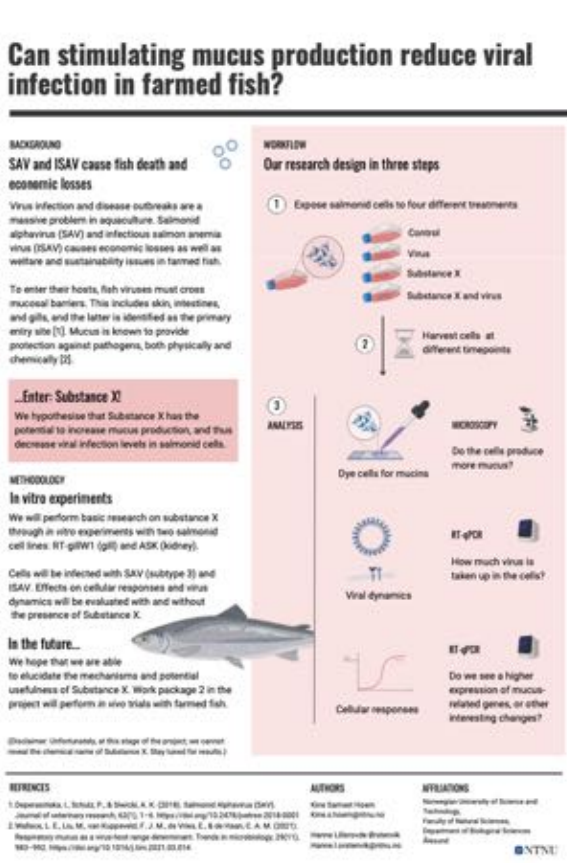



*Photo. Mariana Ferreira and Kine Samset Hoem*

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## Join us at AQUA2024 in Copenhagen, Denmark

# AQUA 2024 Overview

The AQUA events are co-organised by the European Aquaculture Society (EAS) and the World Aquaculture Society (WAS) and are held every six years. Past events were held in Nice (2000), Florence (2006), Prague (2012) and Montpellier (2018). **AQUA 2024 will take place from August 26-30 in the Danish capital of Copenhagen**. It will comprise a scientific conference, trade exhibition, industry forums, workshops, student events and receptions. The event will highlight the latest aquaculture research and innovation to underpin continued growth of this exciting food production sector.

**It will be a showcase for Denmark, and its innovation leadership in several key technologies crucial for future aquaculture, but also a meeting and exchange platform for experts from around the world. Sponsorship opportunities are numerous and include Gold and Silver Sponsorship, Session sponsors, Presidents Reception, Coffee breaks and various advertising possibilities.**

The overarching them of AQUA 2024 is **BLUE FOOD, GREEN SOLUTIONS** and the scientific conference will include more than 60 sessions covering all aspects of aquaculture research.


**We look forward to having you with us…**