AQUA EXCEL 2020

AQUAculture infrastructures for EXCELlence in European fish research towards 2020 — AQUAEXCEL2020

D2.3c - Report on each of the brokerage events: #3

AquaTT, EATiP

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This publication reflects only the view of the author, and the European Commission cannot be held responsible for any use which may be made of the information contained therein

Executive Summary

Objective: The AQUAEXCEL[2020] industry brokerage events aimed to create a forum for the AQUAEXCEL[2020] research results, promoting engagement and exchange between researchers and potential beneficiaries, in particular industry stakeholders.

Rationale: Knowledge generated within the framework of the AQUAEXCEL[2020] project, both through the Transnational Access (TNA) programme, the Networking Activities (NA) and the Joint Research Activities (JRA), were communicated to the aquaculture industry community through the following parallel brokerage event activities: i) Innovative Output Catalogues (describing AQUAEXCEL[2020] knowledge OUTPUTs), ii) different types of presentations during the project industry brokerage events, and iii) AQUAEXCEL[2020] exhibition booths at the Aquaculture Europe events with dedicated information on the project actions and results. As the 3rd and last industry brokerage event could not take place physically as planned, because of Covid-19 restrictions, two alternative webinars were organised instead. In addition, selected Innovative Outputs were presented through video recordings and made available on the project website. OUTPUTS generated within the project were also communicated to the aquaculture industry through other events such as EATiP meetings, Federation of Aquaculture Producer meetings, AquaNor and other major aquaculture events, and communication by partners, and IRAP members to their networks.

Knowledge OUTPUTS presented at the AQUAEXCEL[2020] industry brokerage events were selected by the project Industry and Research Advisory Panel (IRAP), identified as being high priority OUTPUTS for the aquaculture industry in Europe at present.

Main Results: The third AQUAEXCEL[2020] industry brokerage had been planned to take place at Aquaculture Europe 2020, scheduled to take place in Cork (Ireland), in September / October 2020. However, this conference was postponed until 2021 (after the end of AQUAEXCEL[2020]) due to the Covid-19 pandemic and so the brokerage event could not take place at this conference. Instead, it was decided to virtually present selected OUTPUTS from the project and TNA programme across a series of webinars and recorded presentations.

The first of these webinars was titled “Aquafeed of the Future” and was a joint collaboration between EATiP and AQUAEXCEL[2020]. Along with other speakers, it featured two TNA OUTPUTS:

1. Effect of black soldier fly meal inclusion on production of pikeperch by Laura Gasco (University of Turin, Italy)

2. LSAqua protein source for rainbow trout diets by Paula Sole-Jiminez (LSAQUA, Belgium / Spain)

The second webinar was titled “Innovations to Support Fish Welfare” and was again a joint collaboration between EATiP and AQUAEXCEL[2020]. Along with other speakers, it featured two TNA OUTPUTS:

1. ***Novel sensors to measure distributed flow in aquaculture sea cages by Asko Ristolainen (Tallinn University of Technology, Estonia)***

2. ***Improving salmon feeding process with the Smart System for Feeding Control (SICA) by Rosa Martínez Álvarez-Castellanos (CTN-Marine Technology Centre, Spain)***

The presenters of the knowledge OUTPUTS were instructed in advance of their presentations to ensure focus on an industry audience. An online feedback session (through Mentimeter – interactive presentation software) took place after each of the AQUAEXCEL[2020] OUTPUT presentations to gauge the audiences' interest in the OUTPUTS and how relevant they are to industry stakeholders. Time was also allocated for questions from the audience.

270 people registered to attend the "Aquafeed of the Future" webinar and 189 people attended the webinar.

310 people registered to attend the "Innovations to Support Fish Welfare" webinar and 153 attended.

In addition, several OUTPUT owners were invited to record a video presentation of their outputs. These videos were uploaded to YouTube and to the project website (https://aquaexcel2020.eu/results), were they remain available to view. The videos are as follows:

1. ***How does transfer from cages to tanks affect European seabass? by Orestis Stavrakidis-Zachou (Hellenic Centre for Marine Research, Greece)***
2. ***Effect of a novel underwater robot on fish behaviour and welfare in sea cage by Asko Ristolainen (Taltech, Estonia)***
3. ***Bacteriophages, the "good" viruses as antibacterial agents in aquaculture by Panos G. Kalatzis (University of Copenhagen)***
4. ***Handling of Atlantic salmon smolts – developing a best practice by Trine Ytrestøyl (Nofima)***

Team members involved: Rebecca Doyle (AquaTT), Marieke Reuver (AquaTT), Peadar O'Raifeartaigh (AquaTT), Sive Finlay (AquaTT), Catherine Pons (EATiP), Alexandra Neyts (EATiP).

Table of Contents

1 Introduction

The AQUAEXCEL2020 industry brokerage events were aimed to create a forum for engagement and exchange between researchers and potential beneficiaries of the research results, in particular industry stakeholders.

Knowledge generated within the framework of the AQUAEXCEL2020 project, both through the Transnational Access (TNA) programme, the Networking Activities (NA) and the Joint Research Activities (JRA), were communicated to the aquaculture industry community through the following parallel brokerage event activities: i) Innovative Output Catalogues (describing AQUAEXCEL2020 knowledge OUTPUTs), ii) different types of presentations during the project industry brokerage events, and iii) AQUAEXCEL2020 exhibition booths at the Aquaculture Europe events with dedicated information on the project actions and results. As the 3rd and last industry brokerage event could not take place physically as planned, because of Covid-19 restrictions, two alternative webinars were organised instead (more information below). In addition, selected Innovative Outputs were presented through video recordings and made available on the project website.

OUTPUTs generated within the project were also communicated to the aquaculture industry through other events such as EATiP meetings, Federation of Aquaculture Producer meetings, AquaNor and other major aquaculture events, communication by partners, and IRAP members to their networks.

Knowledge OUTPUTS presented at the AQUAEXCEL2020 industry brokerage events were selected by the project Industry and Research Advisory Panel (IRAP), as being high priority OUTPUTS for the aquaculture industry in Europe at present. Innovative Output Catalogues were developed and disseminated for those high potential OUTPUTS. Researchers involved in the development of selected AQUAEXCEL2020 OUTPUTS were invited to present at the industry brokerage events.

The third AQUAEXCEL2020 industry brokerage event had been planned to take place at Aquaculture Europe 2020, in Cork (Ireland), in September / October 2020. However, this conference was postponed until 2021 (after the end of AQUAEXCEL2020) due to the Covid-19 pandemic and so the brokerage event could not take place at this conference. Instead, it was decided to virtually present selected OUTPUTS from the project and TNA programme across a series of webinars and video presentations.

The first webinar was dedicated to the topic "**Aquafeed of the Future**" and took place on 30 October 2020, 10am – 12pm CET.

The second webinar was on "**Innovations to Support Fish Welfare**" and it took place on 26 November 2020, 10am – 12pm CET.

Lastly, several OUTPUT owners were asked to record PowerPoint presentations, which were added to the AQUAEXCEL2020 website. More details are included below.

2 Before the Event

Preparation of the event

To ensure the AQUAEXCEL[2020] industry virtual events would be interesting for, and attract their core target audience, namely aquaculture industry stakeholders, the organisers carefully devised the programme focusing on its target audience.

The main aim of the events was to create a forum for engagement and exchange between researchers and potential industry beneficiaries of the research results generated from the AQUAEXCEL[2020] project. AQUAEXCEL[2020] produces many strong research results (OUTPUTS), of which numerous are expected to be relevant to the European aquaculture industry in particular. To facilitate successful transfer and exploitation of these OUTPUTS, the project has set up a procedure to collect and analyse all OUTPUTS and select those that could potentially be applied and have impact on the European aquaculture industry. In advance of the 3rd industry brokerage event, the project's Industry & Research Advisory Panel (IRAP) met twice to discuss all OUTPUTS produced thus far and select those OUTPUTS they identified as having potential high impact on industry. The IRAP selected several OUTPUTS which they felt would be of high interest to an industry audience, focused mostly on the initial Aquaculture Europe event that was to take place in Ireland, and so with a significant Irish industry attendance in mind. As the Aquaculture Europe physical event in Ireland was cancelled, and the event moved online instead making it open for a larger and broader audience than originally foreseen, an alternative shortlist was developed by AquaTT, based on the IRAP meeting discussions and decisions. The shortlist was presented to the EATiP national Mirror Platform members, who were given the opportunity to decide which OUTPUT topics were of most interest to them. EATiP Mirror Platforms are industry-led national or regional aquaculture networks. The OUTPUT owners of the industry selected OUTPUTS were then invited to present on these at one of the two virtual webinars. Four OUTPUTS were selected and their associated authors agreed to present at the webinar events, which were recorded and added to the AQUAEXCEL[2020] website, for promotion to an even wider audience. In addition, other OUTPUT owners were invited to record an industry-focused presentation on their OUTPUT, which was then uploaded to the project website also. A total of 4 OUTPUT presentations are available, including the following:

1. ***How does transfer from cages to tanks affect European seabass? by Orestis Stavrakidis-Zachou (Hellenic Centre for Marine Research, Greece)***
2. ***Effect of a novel underwater robot on fish behaviour and welfare in sea cage by Asko Ristolainen (Taltech, Estonia)***
3. ***Bacteriophages, the "good" viruses as antibacterial agents in aquaculture by Panos G. Kalatzis (University of Copenhagen)***
4. ***Handling of Atlantic salmon smolts – developing a best practice by Trine Ytrestøyl (Nofima)***

One additional OUTPUT owner has indicated they hope to record a presentation on their OUTPUT (Parentage Assignment in Meagre) in the coming weeks.

It was advised (by the industry members of EATiP and the national Mirror Platforms) and decided to keep the overall duration of the virtual events short and efficient (2 hours for each webinar), taking into account the limited time and resources of industry attendees. The webinars therefore focused on short presentations of each of the selected OUTPUTS in a non-academic, industry-focused format, along with presentations by other (predominantly industry) speakers invited by EATiP, on related topics. AquaTT developed a PowerPoint template with clear instructions, to ensure the AQUAEXCEL[2020] presenters tailored their presentation to an

industry-focused audience. Presenters were instructed to prepare OUTPUT presentations using clear, concise language, understandable to a non-scientific audience and to make use of pictures, graphs, etc where possible. Information presented had to identify a clear industry need, the solution provided by the OUTPUT, the target market and economic impact, all key factors for industry stakeholders.

To keep attention focused, and to support monitoring the impact of the OUTPUTS as well as the event itself, it was decided to include interactive engagement as part of the programme, through means of Mentimeter, an online interactive presentation tool.

In relation to the additional video presentations of other selected OUTPUTS, the same PowerPoint template as was used in the webinars was sent to these OUTPUT owners. They were requested to present for a maximum of 8 minutes and to send the recording to AquaTT.

Promotion of the events

The webinars were promoted via the EATiP and AQUAEXCEL2020 websites, targeted emails and social media, to interested stakeholders in the aquaculture research and industry communities.

Fig 1: Aquafeed of the Future Webinar promoted on AQUAEXCEL2020 website.

AQUAFEED OF THE FUTURE – WEBINAR OCTOBER 30TH

9 October 2020 / in _, AQUAEXCEL2020, EATIP Events / by Martine Meland

The Farm to Fork Strategy aims to reduce the environmental and climate impact of animal production, and to support the ongoing transition towards more sustainable livestock farming. Therefore, the European Commission will facilitate the placing on the market of sustainable and innovative feed additives. EATiP acknowledges the limitations on specific resource supplies for compound feeds. In addition to contributing to the sustainability of the sector, it is critical that alternative feed ingredients should not reduce the dietary and health attributes of the final product. The aim of this webinar is to show the potential of new ingredients for aquafeed, to highlight innovations in the use of algae, insects and single-cell proteins as promising feed ingredients and to stimulate discussions and potential project collaboration among attendants.

The forum is organised in collaboration with the EU funded project AQUAEXCEL2020.

Agenda

Welcome by the EATIP

Opening talk.

The potential of new ingredients for aquaculture – a review of the current situation. **Alex Obach** / ***FEFAC / Skretting ARC***

Insects

- Insects in Aquaculture market. **Adriana Casillas** / ***CEO in MEALFOOD Europe***
- Effect of black soldier fly meal inclusion on production of pikeperch AQUAEXCEL2020. **Laura Gasco** / ***University of Turin***

Single-cells

- Microfood for macrochallenges. **Allan LeBlanc** / ***CALYSTA***
- LSAqua protein source for rainbow trout diets AQUAEXCEL2020. **Paula Sole-Jiminez** / ***LSAQUA***

Algae

- Unlocking the magnificent potential of algae in functional aquafeeds. **Jorge Dias** / ***SPAROS LDA***

Open discussion. *Chair:* **Yolanda Molares**, ***Cluster ACUIPLUS***

Webinar conclusions

Fig 2: Aquafeed of the Future Webinar promoted on EATiP website.

Fig 3: Innovations to Support Fish Welfare Webinar promoted on AQUAEXCEL2020 website.

INNOVATIONS TO SUPPORT FISH WELFARE – WEBINAR

6 November 2020 / in _ / by Martine Meland

REGISTRATION LINK

Europe has one of the world's highest standards of animal welfare. It provides the European aquaculture sector with a competitive advantage in the consumer's search for safe, healthy and environmental-friendly food products. The Farm to Fork Strategy, which is at the heart of the European Green Deal, is aiming to strengthen this position. The EATiP Forum will highlight a set of new technologies and scientific innovations that can contribute to supporting fish welfare and hence the overall sustainability and public acceptance of aquaculture. Join us for short talks about innovative solutions and new findings, discussions with panel members and for letting us know what you are interested in!

The forum is organised in collaboration with the EU funded project AQUAEXCEL2020.

Register HERE

Fig 4: Innovations to Support Fish Welfare Webinar promoted on EATiP website.

The video recordings were promoted on the AQUAEXCEL2020 project website and through the consortium's networks. They were also promoted individually on the project's social media.

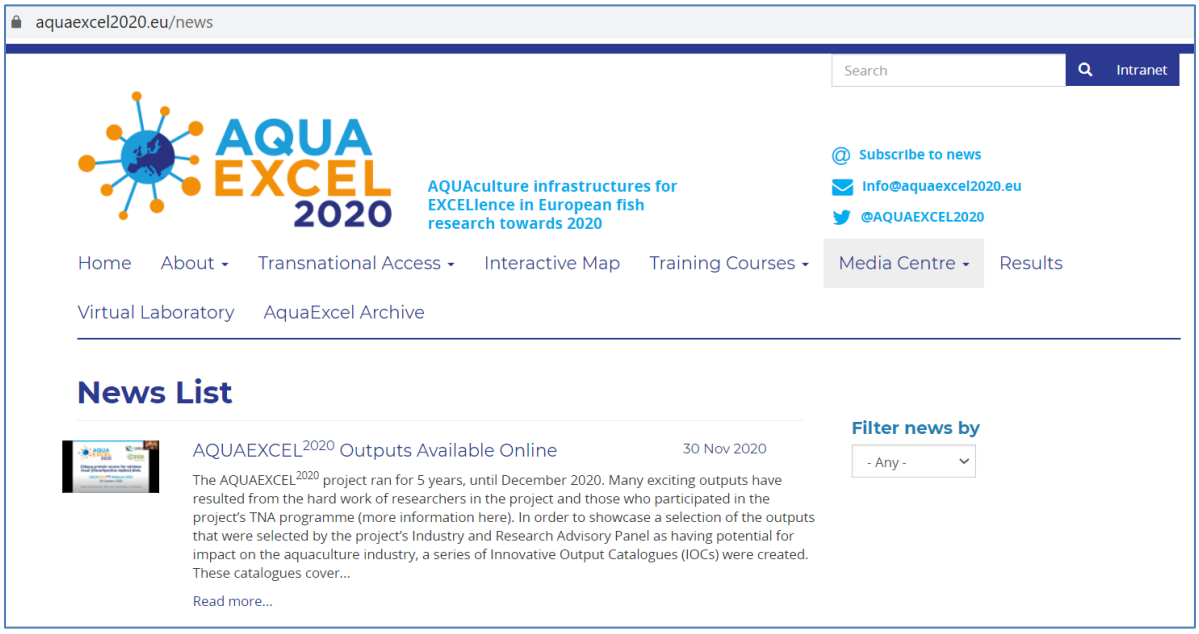


Fig 5: Promotion of the Innovative Output Catalogues and Videos available on the project website.

Innovative Output Catalogues

AquaTT developed Innovative Output Catalogues for each knowledge OUTPUT that was presented at the webinars and by video (see Annex 2). This involved collecting project catalogue templates from the knowledge OUTPUT owners. These templates have a number of sections to be completed, including information on the research carried out, who the results would have most impact for, etc. AquaTT then worked with the researchers to expand on the information they were given and develop it into an Innovative Output Catalogue that was concise and focused on aquaculture industry end users. Innovative Output Catalogues are easy-to-read and attractive promotional leaflets to disseminate and facilitate knowledge transfer of high-potential OUTPUTS. The Catalogues focus on conveying information of relevance to industry end-users, highlighting aspects such as potential impact, underlying science, results, end-users and potential applications for each type of end-user, and status in terms of Technology Readiness Level, explaining what further activities are foreseen. The Innovative Output Catalogues were uploaded to the AQUAEXCEL2020 website ahead of the virtual events and shared on social media, and will be available for download to any interested party.

3 The Virtual Events

The first virtual event "Aquafeed of the Future" was a joint AQUAEXCEL2020 – EATiP event that took place on 30 October 2020, 10am – 12pm CET, via Zoom Webinar. 270 people registered to attend the event and 189 attended on the day. See Annex 6 for the list of organisations / companies from which people were registered to attend. The event was opened with a welcome by Alexandra Neyts (EATiP), who explained the purpose of the event, the rules for participants and speakers, and encouraged speakers to engage and ask questions. Yolanda Molares of ACUIPLUS and EATiPs Spanish Mirror Platform then introduced the Mirror Platform. Next, Alexandra introduced the keynote speaker – Alex Obach of FEFAC / Skretting ARC who presented an overview of the current situation of the potential of new ingredients for aquaculture. Following this there was an audience Q&A session.

After this, Adriana Casillas, the CEO of MEALFOOD Europe, presented on insects in the aquaculture market. Following Adriana, was Laura Gasco's presentation titled "Effect of Black Soldier Fly Meal Inclusion on Production of Pikeperch." Laura Gasco (University of Turin, Italy) carried out her research in the facilities of University of South Bohemia in Ceske Budejovice through the AQUAEXCEL2020 TNA programme. After Laura's presentation a Mentimeter session was carried out (see Section 4 Feedback Assessment below).

The next section of the webinar focused on single cell protein (SCP). First, a presentation titled "Microfood for Macrochallenges" was given by Allan LeBlanc (Vice President of Market Development) of CALYSTA. Following this, was the second AQUAEXCEL2020 speaker. Paula Solé Jiménez of LSAqua gave a presentation entitled "LSAqua protein source for rainbow trout diets." LSAqua have developed a protein source that includes SCP. Paula carried out her research in the facilities of INRAE (France) through the AQUAEXCEL2020 TNA programme. There were several questions about SCP for the two speakers. Again, a Mentimeter was carried out focused on Paula's presented topic (see Section 4 Feedback Assessment below).

Lastly, Jorge Días (SPAROS LDA) presented on unlocking the magnificent potential of algae in functional aquafeeds. This was followed by some questions and then a general Q&A session for all speakers. There were many questions asked by the audience and due to time constraints, some questions were read out and answered by the panelists, and some questions were answered by the panelists in the Zoom chat box function.

Fig 6: Slide from Laura Gasco's presentation "Effect of Black Soldier Fly Meal Inclusion on Production of Pikeperch"

Fig 7: Opening slide of Paula Solé Jiménez (LSAqua) at the Aquafeed of the Future webinar.

A transcript of the questions asked by the audience in both the Chat box and the Q&A box can be found in Annex 4 below.

The second virtual event "Innovations to Support Fish Welfare" was a joint AQUAEXCEL[2020] – EATiP event that took place on 26 November 2020, 10am – 12pm CET, also via Zoom Webinar. The event was opened with a welcome by Alexandra Neyts (EATiP), who explained the purpose of the event, the rules for participants and speakers, and encouraged speakers to engage and ask questions. Yolanda Molares of ACUIPLUS and EATiPs Spanish Mirror Platform then introduced the Mirror Platform. Next, Alexandra introduced the first speaker - Sven Jørund Kolstø (CEO Optoscale) who presented on remote monitoring and analysis and fish welfare indicators in realtime. Next, Asko Ristolainen (Tallinn University of Technology) presented the results of a project carried out through the AQUAEXCEL[2020] TNA programme, using SINTEF (Norway) facilities. His presentation was titled "Novel sensors to measure distributed flow in aquaculture sea cages." After Asko's presentation a Mentimeter session was carried out (see Section 4 Feedback Assessment below).

Following this was a presentation by Mette Cristine Schou Frandsen (OxyGuard International) on water quality monitoring in relation to animal welfare. The next speaker, Rosa Martínez Álvarez-Castellanos (CTN-Marine Technology Centre) carried out a project through the AQUAEXCEL[2020] TNA programme, using SINTEF (Norway) facilities. Her presentation was titled "Improving Atlantic salmon feeding process efficiency with the Smart System for Feeding Control (SICA)." Again, a Mentimeter was carried out focused on Rosa's presented topic (see Section 4 Feedback Assessment below).

Following this, Dominik Ewald (Co-founder and CSO Monitorfish) presented on AI-based fish health diagnosis. Lastly, Charles McGurk (R&D manager Skretting ARC) presented on the potential of functional feeds to improve fish welfare.

This was followed by some questions and then a general Q&A session for all speakers. There were many questions asked by the audience and, as with the first webinar, due to time constraints, some questions were read out and answered by the panellists, and some questions were answered by the panellists in the Zoom chat box function.

Fig 8: Slide from Asko Ristolainen's presentation "Novel sensors to measure distributed flow in aquaculture sea cages"

Fig 9: Slide from Rosa Martinez-Alvarez's presentation "Improving salmon feeding process with the Smart System for Feeding Control (SICA)."

In addition to the OUTPUTS presented at the webinars, the following OUTPUT owners were approached and agreed to record a video of their presentation which was then uploaded to YouTube and the AQUAEXCEL[2020] website:

1. How does transfer from cages to tanks affect European seabass? Orestis Stavrakidi-Zachou (Hellenic Centre for Marine Research)
2. Effect of a novel underwater robot on fish behaviour and welfare in sea cage by Asko Ristolainen (Taltech, Estonia)
3. Bacteriophages, the "good" viruses as antibacterial agents in aquaculture by Panos G. Kalatzis (University of Copenhagen)
4. Handling of Atlantic salmon smolts – developing a best practice by Trine Ytrestøyl (Nofima)

A fifth output will be recorded in the coming weeks and will also be uploaded to the website. This output is:

5. Parentage assignment in meagre by Costas Tsigenopoulos (Hellenic Centre for Marine Research, Greece)

All videos can be viewed in the "Videos" section here: https://aquaexcel2020.eu/results

Fig 10: Recorded presentation by Orestis Stavrakidi-Zachou

Fig 11: Recorded presentation by Asko Ristolainen

Fig 12: Recorded presentation by Panos G. Kalatzis

Fig 13: Recorded presentation by Trine Ytrestøyl

4 Feedback assessment

During the two webinars, a real-time feedback survey was performed using two "Mentimeter" sessions designed and asked by AquaTT. Participants were asked to log into an active online survey and answer some questions to get insight into aquaculture industry needs and wishes in general and questions related to the presented OUTPUTS.

4.1 Aquafeed of the Future Mentimeters

4.1a. Effect of Black Soldier Fly Meal Inclusion on Pikeperch

Approximately 60 people completed the Mentimeter survey relating to this OUTPUT. The first question showed that 30% of respondents were from a commercial company, 49% were from a university / research institute, 17% were from a non-profit organization and 4% were from another type of organization. This showed a good representation of the different aquaculture organisations that attended the webinar. The second question focused on understanding the audience's awareness/knowledge of the AQUAEXCEL2020 project. 69% already knew about the project/had been involved in some way, while 31% answered that they did not know about the project until now. This shows that AQUAEXCEL2020 was already well known in the aquaculture community and that the webinars are a good way to raise further awareness of the AQUAEXCEL2020 project. Following this, participants were asked if they considered fish meal alternatives as essential for the development of the aquaculture sector in Europe. 96% of respondents answered "yes" to this question, showing the importance of this research area in AQUAEXCEL2020. Next, participants were asked if they consider insect meal to currently be a valuable alternative component of aquaculture feeds. 71% believed that it is a promising new aquafeed ingredient and 13% answered "yes, evidence shows that it improves aquaculture production results." Only 16% answered no, with 11% stating they needed more proof and 5% saying they think evidence shows that it gives poorer growth results that with 'normal' feed. When asked what the main challenge with insect meal as a substitute for fish meal is, 31% said volume capacity, 28% said costly production, 26% said potential health and performance issues, 12% said other challenges and 3% felt there is no major challenge at all. The fact that only 3% felt there was no challenge shows the importance of research on this topic. When asked if they were interested in getting more information on insect meal as a replacement to fish meal, 20% said 'yes, in particular I would like more information for pikeperch diets and on this AQUAEXCEL2020 output" and 70% said "yes, I would like more information in general about insect meal. 10% said it was not relevant for their research / work and no one answered that they were not interested in general. The final questions asked the audience which is the most important factor when considering the use of alternatives to fish meals. 8% answered fish growth, 24% answered fish health and welfare, 15% answered feed cost and 53% answered environmental sustainability concerns. Overall, the survey showed the importance of research in this area and the impact AQUAEXCEL2020 research has in this area. Please see Annex 5 for the resulting pdf Mentimeter report.

4.1.b LSAQua protein source for rainbow trout diets

Approximately 63 people completed this Mentimeter session of the Aquafeed of the Future webinar. This time, 32% were from a commercial company, 49% were from a research institute / university and 19% were from a non-profit organization. When asked if they considered SCP to be a valuable component of aquaculture feeds, 72% said "yes, I believe this is a promising new ingredient", 11% replied "yes, evidence shows that it improves aquaculture production results", 2% replied "no, I think evidence shows it gives poorer results", 10% replied "no, I think more proof is needed first" and 5% replied "not applicable." Next, the audience were asked what they thought is the main challenge with SCP as a substitute for fish meal (more than one answer was possible). 29% said volume capacity, 36% said costly production, 25% said potential health and performance issues, 6% said other challenges and 4% said there was no major challenge. Again, this shows the importance of supporting research in this area in order

to address the challenges that industry and academia see in this area of alternative feed production. When asked if they were interested in getting more information on SCP as a fish meal replacement, 86% said yes (29% of these answered "yes, in particular I would like more information for trout diets and on this AQUAEXCEL2020 output), and only 3% said no, with 11% saying it was not relevant for them. The final question asked the audience what the most important factor for them is when considering alternatives to fish meals. 56% answered environmental sustainability considerations, 10% said feed cost, 22% said fish health and welfare and 13% said fish growth. Again, this survey has shown showed the importance of research in this area and the impact AQUAEXCEL2020 research has in this area of aquaculture. Please see Annex 5 for the resulting pdf Mentimeter report.

4.2 Innovations to Support Fish Welfare Mentimeters

4.2.a Novel sensors to measure distributed flow in aquaculture sea cages

Approximately 62 people completed the Mentimeter relating to this output. 29% were representing a commercial company, 40% were representing a university or research institute, 4% were representing a policy- or decision-making organisation, 16% were representing a non-profit organisation and 11% selected "other". The second question focused on understanding the audience's awareness/knowledge of the AQUAEXCEL2020 project. 69% already knew about the project/had been involved in some way, while 31% answered that they did not know about the project until now. This again shows that AQUAEXCEL2020 is well known within its community and that the webinars are a good way to raise even further awareness of the AQUAEXCEL2020 project. Next, the participants were asked that if the novel sensors were available for purchase, would they be interested in using them. 21% said they felt the sensors would be beneficial for their work/research and 30% said yes, but that they would need more information. The participants were then asked if they consider this type of distributed flow monitoring through offshore aquaculture cages to be important to ensure fish welfare, to which 59% said yes. The final question asked participants if they were interested in getting more information on technological innovations to improve fish welfare. 91% answered either yes, they would like more information on this particular output regarding the sensors or yes, they would like more information on technological innovations to improve welfare, in general. Participants were then directed to contact Asko, or visit the AQUAEXCEL2020 website to view this Innovative Output Catalogue.

4.2.c Improving Atlantic salmon feeding process efficiency with the Smart System for Feeding Control (SICA)

Approximately 58 people completed the Mentimeter relating to this output. 26% were representing a commercial company, 51% were representing a university or research institute, 5% were representing a policy- or decision-making organisation, 13% were representing a non-profit organisation and 5% selected "other". The participants were then asked what they believed is the most important factor when considering the use of new technological solutions in aquaculture. 16% answered economic benefits, 62% answered better health and welfare, 16% answered environmental sustainability benefits, 5% answered other and 1 person replied that they did not know. The high percentage who valued fish health and welfare demonstrates the importance of this type of forum to the aquaculture community, providing the opportunity to discuss, question and learn about new innovations in aquaculture. The participants were

then asked what they consider the most important fish welfare area that should be addressed using innovative solutions and new technologies. For this question participants could select three answers from the options provided. Water quality was selected 27 times, physical conditions 19 times, transport 6 times, handling 17 times, feeding 21 times, management 10 times, fish health 44 times, and other 3 times. Again, this shows the huge importance the aquaculture community places on the type of research conducted through the AQUAEXCEL[2020] TNA programme. The participants were then asked that when the SICA system is commercially available would they be interested in purchasing it. 32% replied that they would either be interested, or would be interested but would need more information. Only 10% said they would not be interested with the remainder answering that it would not be relevant for their research/work. Finally, participants were asked if they are interested in getting more information on technological innovations to improve fish welfare. 97% replied either that they would be interested in the SICA specifically, or in technological innovations to improve fish welfare in general. Participants were then directed to contact Rosa, or visit the AQUAEXCEL[2020] website to view her Innovative Output Catalogue.

5 After the Event

All Innovative Output Catalogues from the OUTPUTS presented at the brokerage event are available online on the project's website under **Innovative Outputs**: https://aquaexcel2020.eu/results. This will contribute to the promotion of both the TNA and AQUAEXCEL[2020] research results on a wider level. See Annex 2 for all Innovative Output Catalogues related to OUTPUTS presented at the events described in this report.

The webinar presentations (after permission from their owners) have been uploaded to the **VIDEOS** section of the AQUAEXCEL[2020] website: https://aquaexcel2020.eu/results

The webinar presentation pdfs (after permission from their owners) have also been added to EATiP's website: http://eatip.eu/?p=4384 and http://eatip.eu/?p=4407.

All other video recordings of presentations can also be found in the **VIDEOS** section of the AQUAEXCEL[2020] website: https://aquaexcel2020.eu/results

All knowledge OUTPUT presenters were requested to complete a feedback survey, which includes the identification of additional end-users following the virtual events, the description of follow-up discussions and interested stakeholders and possible future collaborations. For more information please see deliverable report D2.5.

A selection of suitable OUTPUTS will also be added to the European Commission's Horizon Results Platform.

6 Conclusion

Knowledge OUTPUTS presented at the AQUAEXCEL[2020] virtual industry brokerage events were selected by the project Industry and Research Advisory Panel (IRAP), as being high priority OUTPUTS for the aquaculture industry in Europe at present.

The AQUAEXCEL[2020] virtual industry brokerage events were successfully held in October and November 2020. The webinars were integrated as part of the EATiP forums since it was considered to be an effective and relevant forum for engagement and exchange between researchers and potential beneficiaries of the AQUAEXCEL[2020] research results, namely aquaculture industry stakeholders. In addition, other OUTPUTS were presented through recorded presentation videos and uploaded to the project website.

Knowledge generated within the framework of the AQUAEXCEL[2020] project was communicated to the aquaculture industry community through means of presentations on selected Knowledge OUTPUTS. In addition, Innovative Output Catalogues (describing the AQUAEXCEL[2020] knowledge OUTPUTs) with dedicated information on the project OUTPUTS were shared online (through the project website and social media).

7 Glossary

AQUAEXCEL^{2020}: AQUAculture Infrastructures for EXCELlence in European Fish Research towards 2020

EATiP: European Aquaculture Technology and Innovation Platform

FEAP: Federation of European Aquaculture Producers

IRAP: Industry Research Advisory Panel

JRA: Joint Research Activity

SCP: Single Cell Protein

8 Document information

EU Project N°	652831	**Acronym**	AQUAEXCEL[2020]
Full Title	AQUAculture Infrastructures for EXCELlence in European Fish Research towards 2020		
Project website	https://aquaexcel2020.eu/		

Deliverable	**N°**	D2.3	**Title**	Report on each of the brokerage events
Work Package	**N°**	2	**Title**	NA2 – Fostering Innovation from RIs

Date of delivery	**Contractual**	12/2020 (Month 63)	**Actual**	12/2020 (Month 63)
Dissemination level	X	**PU Public, fully open, e.g. web**		
		CO Confidential, restricted under conditions set out in Model Grant Agreement		
		CI Classified, information as referred to in Commission Decision 2001/844/EC.		

Authors (Partner)	AquaTT, EATiP			
Responsible Author	**Name**	Rebecca Doyle (AquaTT), Marieke Reuver (AquaTT) Catherine Pons (EATiP) Alexandra Neyts (EATiP)	**Email**	rebecca@aquatt.ie; marieke@aquatt.ie; Catherine@eatip.eu; alexandra@eatip.eu

Version log			
Issue Date	**Revision N°**	**Author**	**Change**
dd/mm/yyyy			Ex: first version/first review by WP leader etc/ version

Annex 1: Webinar Agendas

1. Aquafeed of the Future Agenda (30 October 2020)

AQUAFEED OF THE FUTURE – WEBINAR OCTOBER 30TH

9 October 2020 / in _, AQUAEXCEL2020, EATiP Events / by Martine Meland

The Farm to Fork Strategy aims to reduce the environmental and climate impact of animal production, and to support the ongoing transition towards more sustainable livestock farming. Therefore, the European Commission will facilitate the placing on the market of sustainable and innovative feed additives. EATiP acknowledges the limitations on specific resource supplies for compound feeds. In addition to contributing to the sustainability of the sector, it is critical that alternative feed ingredients should not reduce the dietary and health attributes of the final product. The aim of this webinar is to show the potential of new ingredients for aquafeed, to highlight innovations in the use of algae, insects and single-cell proteins as promising feed ingredients and to stimulate discussions and potential project collaboration among attendants.

The forum is organised in collaboration with the EU funded project AQUAEXCEL2020.

Agenda

Welcome by the EATIP

Opening talk.

The potential of new ingredients for aquaculture – a review of the current situation. **Alex Obach** / *FEFAC / Skretting ARC*

Insects

- Insects in Aquaculture market. **Adriana Casillas** / *CEO in MEALFOOD Europe*
- Effect of black soldier fly meal inclusion on production of pikeperch AQUAEXCEL2020. **Laura Gasco** / *University of Turin*

Single-cells

- Microfood for macrochallenges. **Allan LeBlanc** / *CALYSTA*
- LSAqua protein source for rainbow trout diets AQUAEXCEL2020. **Paula Sole-Jiminez** / *LSAQUA*

Algae

- Unlocking the magnificent potential of algae in functional aquafeeds. **Jorge Dias** / *SPAROS LDA*

Open discussion. *Chair:* **Yolanda Molares**, *Cluster ACUIPLUS*

Webinar conclusions

2. Innovations to Support Fish Welfare Agenda (26 November 2020)

INNOVATIONS TO SUPPORT FISH WELFARE – WEBINAR

6 November 2020 / in _ / by Martine Meland

REGISTRATION LINK

Europe has one of the world's highest standards of animal welfare. It provides the European aquaculture sector with a competitive advantage in the consumer's search for safe, healthy and environmental-friendly food products. The Farm to Fork Strategy, which is at the heart of the European Green Deal, is aiming to strengthen this position. The EATiP Forum will highlight a set of new technologies and scientific innovations that can contribute to supporting fish welfare and hence the overall sustainability and public acceptance of aquaculture. Join us for short talks about innovative solutions and new findings, discussions with panel members and for letting us know what you are interested in!

The forum is organised in collaboration with the EU funded project AQUAEXCEL2020.

Register HERE

Agenda:

- Remote monitoring and analysis and fish welfare indicators in realtime. **Sven Jørund Kolstø** / ***CEO Optoscale***
- Novel sensors to measure distributed flow in aquaculture sea cages. AQUAEXCEL2020 **Asko Ristolainen** / ***Tallinn University of Technology***
- Water Quality Monitoring in Relation to Animal Welfare. **Mette Cristine Schou Frandsen** / ***OxyGuard International***
- AI-based fish health diagnosis. **Dominik Ewald** / ***Co-founder & CSO Monitorfish***
- Improving salmon feeding process with the Smart System for Feeding Control (SICA). AQUAEXCEL2020 **Rosa Martínez Álvarez-Castellanos** / ***CTN-Marine Technology Centre***

Annex 2: Innovative Output Catalogues

2.1 LSAqua Protein Source for Rainbow Trout Diets

LSAQUA PROTEIN SOURCE FOR RAINBOW TROUT DIETS

AQUA EXCEL 2020

SUMMARY

This output describes the use of LSAqua Suspro, containing Single Cell Protein, as an alternative feed source for rainbow trout (*Onchorynchus mykiss*). Alternative feed sources are currently an important topic in aquaculture due to the limited availability of fish meal. There were no palatability issues, or negative effects on growth parameters or feed efficiency detected in the trout when LSAqua was used as a fish meal substitute. This study will be of particular interest to trout farmers who wish to use alternatives to fish meal for their stock.

KNOWLEDGE NEED

One of the aquaculture industry's major challenges is the availability of fish meal and fish oil, which have fluctuating costs and sustainability issues. There is a substantial need for alternative fish feed ingredients that do not deplete marine resources, and which result in healthy fish. Another related challenge is the limited knowledge of the nutritional requirements of most cultured fish species. Alternative ingredients in the fish's diet can lead to adverse effects, such as decreased digestion efficiency and increased susceptibility to diseases and stress. Further work is needed to ensure that aquafeeds utilising alternative ingredients can supply the same benefits as fish meal and fish oil. Alternatives must have high biological value and low competitiveness with human food, with established optimum substitution levels for each fish species. One such alternative is LSAqua Suspro, which is unique due to the addition of Single Cell Protein (SCP). LSAqua has been found to be effective in shrimp diets, but its optimal use in diets for other species, such as trout, needs to be determined.

POTENTIAL IMPACT

- Substituting trout diets with LSAqua Suspro will reduce the need for fish meal, which is costly, volatile and unsustainable. This could contribute to a more sustainable aquaculture sector.
- The establishment of the optimum level of fish meal substitution with LSAqua for trout opens the door for further research into its applicability for other aquaculture species.
- The findings contribute towards improving ecological and social sustainability of fish feeds, especially if applied to multiple species.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 4 - Sustainable Feed Production; Goal 3. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 INNOVATIVE OUTPUT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

The research underlying this output tested the partial (50 %) and total (100 %) replacement of fish meal in trout diets with LSAqua Suspro. LSAqua Suspro is a mix of byproduct materials and novel protein resources. It is unique due to the addition of Single Cell Protein (SCP). SCPs are dried cells of microorganisms such as bacteria, yeasts, fungi and algae, which are valuable protein sources for the feed industry. They are rich in protein content (60 - 80%) and their biomass also contains vitamins, minerals, lipids and carbohydrates.

RESULTS

- Partial replacement of fish meal with LSAqua Suspro (containing Single Cell Protein (stemming from bacteria)) showed similar results to control feed in feed efficiency and growth parameters and is deemed good, safe and sustainable.
- The control diets showed better results in feed efficiency and growth parameters than total replacement of fish meal with LSAqua Suspro. LSAqua Suspro cannot totally replace fish meal in trout diets in terms of growth and feed efficiency.
- No negative effect on palatability was detected when the partial and total replacements by LSAqua Suspro were carried out.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Trout feed producers
APPLICATION: Developing and producing novel feed formulations for trout (and potentially other species) based on alternative, effective, safe and sustainable feed sources with high biological value and low competitiveness with human nutrition.

END-USER 2: Trout farmers
APPLICATION: Feeding of aquaculture trout stocks with more sustainable (and potentially cheaper) fish feeds while keeping good production levels, leading to higher profits and reduced environmental impact.

END-USER 3: Aquaculture marketing and lobby groups
APPLICATION: Supporting a sustainable and dynamic image of the aquaculture sector, working towards improving global food security while decreasing environmental impact.

END-USER 4: Aquaculture research community
APPLICATION: Furthering knowledge relating to fish meal replacement and its effect on many aspects (such as growth, digestibility, and flesh quality) in trout and other species. This will support development of the aquaculture sector and contribute to increased levels of Technology Readiness, and progression towards commercialisation.

STATUS

Technology Readiness Level (TRL) 3 – experimental proof of concept

- More research, such as microbiota or digestibility analysis, will complement these results on using LSAqua Suspro as a feed source for trout.
- LSAqua aquafeed innovators continue to analyse the results from this research (i.e. fatty acid analysis and whole-body composition).
- LSAqua Suspro needs to be trialled in other fish species.
- LSAqua Suspro is currently on the market for shrimp production. To view the product, visit **lsaqua.be/en/industry/fish-meal-replacement**

AT A GLANCE

TITLE: LSAqua Protein Source for Rainbow Trout Diets
KNOWLEDGE TYPE: Report
WHERE TO FIND IT: Contact the researcher (details below)
STATUS: In progress
TNA FACILITY USED: Institut National de la Recherche Agronomique (INRAE), France
CONTACT DETAILS: Paula Sole-Jimenez; hello@lsaqua.be; LSAqua; Belgium
PATENTS OR OTHER IPR EXPLOITATIONS: N/A

Designed and developed by AquaIT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This output reflects the views only of the author(s), and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

2.2 Effect of black soldier fly meal inclusion on pikeperch

EFFECT OF BLACK SOLDIER FLY MEAL INCLUSION ON PIKEPERCH

AQUA EXCEL 2020

Pikeperch (Sander lucioperca) used in growth trial with black soldier fly (Hermetia illucens) meal inclusion in experimental recirculating system © Vlastimil Stejskal

SUMMARY

This output concerns the effect of fish meal replacement by black soldier fly (*Hermetia illucens*) in the diet of pikeperch (*Sander lucioperca*). Results indicated that a 50 % substitution of partially defatted black soldier fly meal can be used in pikeperch diets without negative effects on growth rate, feed conversion ratio and fillet yield. These results will be of particular interest to pikeperch farmers who wish to use insect-based meals as an alternative food source for their stock.

KNOWLEDGE NEED

One of the major challenges that the aquaculture industry faces today is the availability of fishmeal and fish oil, which have fluctuating (high) costs and sustainability issues. There is a substantial need for alternative fish feed ingredients that do not deplete marine resources, and which produce healthy fish. Another related challenge is the limited knowledge of the nutritional requirements of most cultured fish species. Alternative ingredients in the fish's diet can lead to adverse effects, such as decreased digestion efficiency and increased susceptibility to diseases and stress. Much work is needed to ensure that aquafeeds utilising alternative ingredients can supply the same benefits as fish meal and fish oil, while maintaining high biological value and low competitiveness with human food. Optimum substitution levels for each fish species must also be established. One such alternative is insect-based meals, such as inclusion of black soldier fly (*Hermetia illucens*), for which the safe substitution level must be established for pikeperch.

Experimental recirculating system © Vlastimil Stejskal

POTENTIAL IMPACT

- Partly substituting pikeperch diets with insect meal reduces the need for fish meal and oil, which are costly, volatile and unsustainable sources. This could lead to a more sustainable and competitive aquaculture sector.
- The findings contribute towards improving ecological and social sustainability of fish feeds, especially if applied to multiple species.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 4 - Sustainable Feed Production; Goal 1. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 INNOVATIVE OUTPUT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

Insects are a natural food source for many fish species. Farmed fish fed with insect-based meals often perform well, depending on the level of substitution. In this study, four levels of fish meal substitution by black soldier fly meal were applied to pikeperch diets: 0 % (control group), 25 %, 50 % and 100 %. The experimental trial lasted 84 days, and three replicates were performed per diet, each containing 50 fish.

The following performance and functions were monitored: growth rate, feed conversion ratio and fillet yield. The Shannon index in gut microbiota was also calculated. The Shannon diversity index (H) is used to characterise species diversity in a community. It accounts for both abundance and evenness of the species present.

RESULTS

- Results indicated that a partially defatted black soldier fly meal can be used for up to 50 % of fish meal substitution in pikeperch diets without negative effect on growth rate, feed conversion ratio and fillet yield.
- 100 % fish meal substitution negatively affected pikeperch performance, feed conversion ratio and fillet yield.
- The use of *Hermetia illucens* meal induces microbiota changes enhancing microbial biodiversity indices in pike perch intestines. An increase of Short Chain Fatty Acid (SCFA) producing bacteria was reported in fish fed *Hermetia illucens* diets.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Pikeperch fish feed producers
APPLICATION: Developing and producing novel feed formulations based on alternative, safe and sustainable feed sources (insect meal) with high biological value and low competitiveness with human nutrition.

END-USER 2: Pikeperch farmers
APPLICATION: Feeding of aquaculture fish stocks with more sustainable (and potentially cheaper) fish feeds while maintaining good production levels, leading to higher profits and reduced environmental impact.

END-USER 3: Aquaculture marketing and lobby groups
APPLICATION: Supporting a sustainable, dynamic image of the aquaculture sector, working towards improving global food security while decreasing environmental impact.

END-USER 4: Aquaculture research community
APPLICATION: Furthering knowledge relating to fish meal replacement and its effect on many aspects, such as growth, health, and taste of the final product, in pikeperch and other fish species. This will support development of the aquaculture sector and contribute to increased levels of Technology Readiness, and aid progression towards commercialisation.

STATUS

Technology Readiness Level (TRL) 4 – the knowledge has been validated in a laboratory environment.

Further research is needed to:

- Establish the precise, optimal *Hermetia illucens* substitution rate in pikeperch diets.
- Investigate further effects of the *Hermetia illucens* diet substitution on other crucial elements such as digestive organs and their tissues and microbiota composition.
- Understand changes in susceptibility to stressors under different diet compositions.
- Examine potential effects on the fish product, e.g. on texture, odour and taste.
- Perform feeding trials on a commercial scale (i.e. validated and demonstrated in an industrially relevant environment).

AT A GLANCE

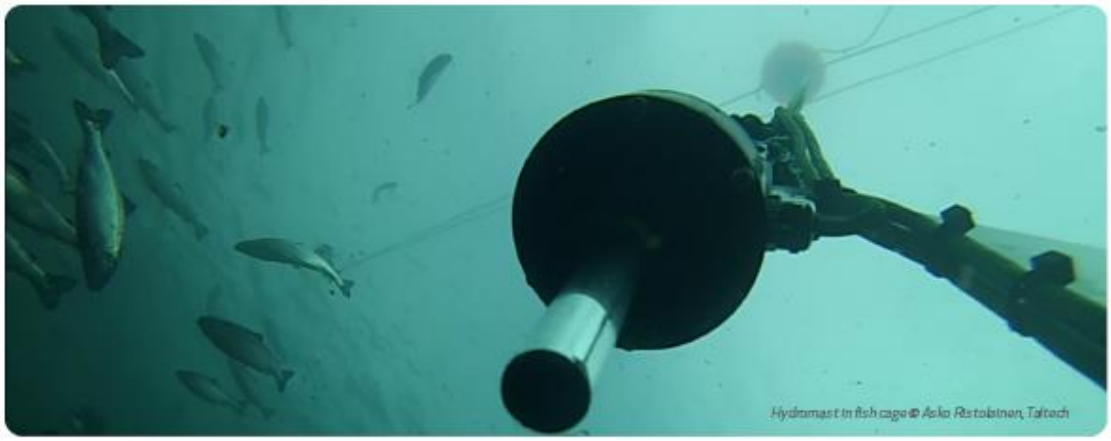
TITLE: Effect of black soldier fly meal inclusion on pikeperch
KNOWLEDGE TYPE: Scientific publication
WHERE TO FIND IT: To be published
STATUS: Draft
TNA FACILITY USED: University of South Bohemia, Faculty of Fisheries and Protection of Waters, Institute of Aquaculture and Protection of Waters, Czech Republic
CONTACT DETAILS: Dr Laura Gasco, DISAFA, University of Turin, Italy; laura.gasco@unito.it
PATENTS OR OTHER IPR EXPLOITATIONS: No

Designed and developed by AquaTT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This output reflects the views only of the author(s), and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

2.3 Novel sensors to measure distributed flow in offshore aquaculture sea cages

NOVEL SENSORS TO MEASURE DISTRIBUTED FLOW IN AQUACULTURE SEA CAGES


Hydromast in fish cage © Asko Ristolainen, Taltech

SUMMARY

This innovative output concerns the development of a pilot installation of novel sensors to measure distributed flow in offshore aquaculture cages. Compared to other available technologies, this novel sensor network measures flow with high spatial and temporal resolution. This approach gives valuable, real-time information on flow circulation and patterns in offshore sea cages, which will support improved cage conditions, production and welfare for fish.

KNOWLEDGE NEED


Hydromast sensor © Joffrey Tuhtan, Taltech

The popularity of marine finfish among consumers in recent years has led to an increased demand for marine aquaculture sites to culture these species. Offshore cages to culture marine finfish have been used successfully since the 1950s and are likely to increase in the future, given land-based and nearshore constraints. Effective monitoring systems are essential in these sea cages, to help farmers track conditions within the cages and manage these accordingly. To understand flow circulation, it is important to measure conditions such as flow patterns with high temporal and spatial resolution, as minimum flows are needed to keep the cages oxidised and clean, and to keep the fish healthy. As fish in cages are usually circulating in a rotational swarm and the cages are moving with the sea level, conventional measuring techniques such as Acoustic Doppler Velocimetry (ADV) and Acoustic Doppler Current Profiler (ADCP) are not appropriate because their precision is decreased by the background motion and also by fish swimming in the field of view of the measuring equipment. Additionally, the flow inside the cage can vary, and ADV or ADCP typically do not give information about the flow field distribution throughout the cage.

POTENTIAL IMPACT

- The output could support increased production of marine finfish in offshore aquaculture cages to respond to the increasing global demand for seafood.
- Improved fish welfare in offshore sea cages due to a better understanding of how oxygen, parasites, waste and nutrients are transported throughout the cage.
- The output could inform the optimal design of offshore aquaculture sea cages to maximise the use of flow to keep cages oxidised and clean. This would also allow for the optimisation of maintenance intervals.

AQUAEXCEL2020 INNOVATIVE OUTPUT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 4 - Sustainable Feed Production; Goal 1. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

UNDERLYING SCIENCE

A pilot installation of novel sensors was deployed in offshore aquaculture cages near the island of Frøya (Norway) to measure the flow direction and magnitude in these cages at different depths. The sensors were developed to measure flows at the seabed and near obstacles where traditional acoustic technology usually fails. The novel sensors are based on converting mechanical vibrations of sensor stems into electrical signals and thus are passive and only measure local flow field. The novel flow meter, the hydromast, uses inertial sensing by the mast and motions of the sensors' body. The two measurements in combination remove background noise. In contrast to ADCP or ADV, they are not as sensitive to disturbances of the flow (for example from swimming fish) and measure flow patterns with high spatial and temporal resolution. These sensors are also cheaper than ADVs and ADCPs. Placing several of these sensors in a network allows measurement of the distribution of flow, and consequently detection of different flows within one cage. The data are transferred wirelessly and can be integrated into existing farm management systems, resulting in real-time identification of problems. For offshore applications, power modules would need to be developed to provide power on-site.

RESULTS

- The installation of novel sensors enables long-term, real-time observation of flow distribution in offshore sea cages.
- Measurements so far confirmed that currents are not uniform along the depth of the sea cage. The currents are stronger closer to the surface and diminish with increasing depth.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Aquaculture Farmers
APPLICATION: Managing health and welfare of fish in sea cages by monitoring the distribution of oxygen, parasites, waste or nutrients throughout the sea cage. Real-time updates would allow for faster identification of problems.

END-USER 2: Aquaculture Researchers
APPLICATION: Increasing the understanding of the distribution of flow in a sea cage can be used as an input to computer models predicting the distribution of oxygen, parasites, waste or nutrients in a sea cage, or directly applied to improve the condition of fish in aquaculture facilities.

END-USER 3: Fish processors and wholesalers
APPLICATION: Good quality certification of aquaculture products through the monitoring of the welfare status of the fish, increasing its appeal to consumers and potentially increased profitability.

STATUS

Technology Readiness Level (TRL) 5 – technology validated in relevant environment

- For future long-term deployments, better ruggedised cables and data loggers are needed.
- A manuscript is currently being prepared for publication.

AT A GLANCE

TITLE: Novel sensors to measure distributed flow in offshore aquaculture sea cages
KNOWLEDGE TYPE: Publication
WHERE TO FIND IT: taltech.ee/en/biorobotics
STATUS: Publication in preparation
TNA FACILITY USED: SINTEF ACE, Norway
CONTACT DETAILS: Maarja Kruusmaa, maarja.kruusmaa@taltech.ee; Asko Ristolainen, asko.ristolainen@taltech.ee. Tallinn University of Technology, Estonia
PATENTS OR OTHER IPR EXPLOITATIONS: US20180239864A1

Designed and developed by AquaIT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This output reflects the views only of the author(s), and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

2.4 Improving salmon feeding process with the Smart System for Feeding Control (SICA)

IMPROVING ATLANTIC SALMON FEEDING EFFICIENCY WITH THE SMART SYSTEM FOR FEEDING CONTROL (SICA)

AQUA EXCEL 2020

SICA deployed in one of the cages near the SINTEF ACE Control Centre. © Hamid Er-Rachdi and Rosa Martínez (CTN)

SUMMARY

This output describes the use of the SICA ("Sistema Inteligente de Control de la Alimentation", or "Smart System for Feeding Control") - a cost-efficient, non-invasive, real-time passive acoustic system, to investigate the behaviour of Atlantic salmon (*Salmo salar*) in offshore sea cages during feeding. SICA utilises artificial intelligence to improve the efficiency of the feeding process in offshore sea environments, resulting in reduced environmental impacts and increased competitiveness for European salmon farmers.

KNOWLEDGE NEED

The salmon farming sector is keen to reduce production costs and increase production efficiency, while also reducing environmental impact. Fish feed is the main production cost for any fish farm company and is also a major source of waste in aquaculture systems, leading to pollution in the marine environment. Improved feeding efficiency is a potential solution to these issues. Most Atlantic salmon production takes place in marine net cages where feed is distributed to fish at the water surface. Computer vision technology has been widely used in recent years for behaviour monitoring, allowing fish appetite estimates to facilitate precision feeding by assessing the velocity, acceleration, degree of aggregation between fish, and also the amount of excess feed in the water. Underwater video methodologies have disadvantages though, such as high cost, accuracy, and the time required for monitoring. There is a need for more autonomous, accurate, real-time and cost-efficient monitoring systems in offshore environments.

© Pixabay

POTENTIAL IMPACT

- Increased knowledge about salmon behaviour in offshore sea cages during the feeding process.
- Increased sustainability of offshore fish farms through a reduction of the environmental impact of the feeding process.
- Increased competitiveness of the salmon farming sector through a reduction in feeding costs and waste.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 4 - Sustainable Feed Production; Goal 2. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 INNOVATIVE OUTPUT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

The Smart System for Feeding Control (SICA) was developed by the Marine Technology Centre (CTN), Spain, to optimize food supply in aquaculture systems. SICA is a non-invasive, passive acoustic system comprised of two modules: Data Logger and Control Unit. The Data Logger, which is deployed within sea cage infrastructures, acquires the data through a passive acoustic sensor, and carries out a pre-processing stage of this data, which is then transmitted via the Wireless Communication Device. The Control Unit controls feed delivery. It is located where the feeding process control is undertaken by farm operators, which can be either a vessel or an offshore platform. In this project, the unit was installed at the SINTEF ACE Control Centre (Norway). It applies the algorithms on data received from the Wireless Communication Device and makes decisions about the feeding process. The SICA system operates autonomously, acquiring and processing the acoustic data. The technology is non-invasive and provides real-time monitoring. The hardware core is relatively simple, passive, and nearly maintenance-free, making it highly cost-effective to operate. It can also be easily integrated into existing farm management systems.

RESULTS

The SICA system was found to be more effective for monitoring feeding behaviour of Atlantic salmon during the feeding process compared to traditional methods undertaken with underwater video cameras. SICA identified low feed intake earlier than the video method.

END-USERS & POTENTIAL APPLICATIONS

- **END-USER 1: Atlantic salmon farmers**
  APPLICATION: Improved efficiency in salmon feeding through the use of non-invasive, cost-efficient and accurate technology.
- **END-USER 2: Technology producers**
  APPLICATION: Production of novel passive acoustic systems for offshore fish farms.
- **END-USER 3: Aquaculture researchers**
  APPLICATION: Improve knowledge on the amount of fish feed that is actually eaten in sea cage environments, and optimise fish feed diets based on measured and validated data.
- **END-USER 4: Aquaculture marketing and and lobbying groups**
  APPLICATION: Supports aquaculture's promotion as a sustainable, dynamic sector, working towards global food security while decreasing environmental impact.

STATUS

Technology Readiness Level (TRL) 6 – technology demonstrated in relevant environment

- SICA has been developed and tested until TRL6. It is currently being tested in different relevant environments under the DEMO-BLUESMARTFEED project financed by the European Maritime and Fisheries Fund of the European Commission and it is expected to be ready for commercialisation (TRL9) in 2022.
- Within the framework of the AQUAEXCEL2020 TNA programme, the technology has been validated in real environmental conditions (in a Norwegian offshore environment).
- A scientific publication based on the results is expected to be published by the end of 2020.

AT A GLANCE

TITLE: Improving salmon feeding process with the Smart System for Feeding Control (SICA)
KNOWLEDGE TYPE: Exploitable scientific result
WHERE TO FIND IT: ctninnova.com/proyectos/sica
STATUS: Publication planned
TNA FACILITY USED: SINTEF ACE, Norway
CONTACT DETAILS: Rosa Martínez Álvarez-Castellanos; CTNAVAL, Spain; rosamartinez@ctnaval.com
PATENTS OR OTHER IPR EXPLOITATIONS: N/A

Designed and developed by AquaTT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This output reflects the views only of the author(s), and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

2.5 Effects of transfer from cages to tanks on European sea bass

EFFECTS OF TRANSFER FROM CAGES TO TANKS ON EUROPEAN SEA BASS

SUMMARY

This output concerns the effects of transfer from cages to tanks on the European sea bass (*Dicentrarchus labrax*). The output provides insight into the general acclimation requirements of the species after transfer. Therefore, it will help to improve the robustness of experimental methodology and the quality of experimental results.

KNOWLEDGE NEED

Handling of fish is necessary, both in commercial farming operations and in research facilities, but causes stress and discomfort for the fish. The acclimation time – the time for the fish to resume normal physiology and behaviour – will depend on the severity of the stress experienced by the fish. An important consideration when conducting fish experiments *in vivo* is the use of animals that are in a stable physiological, biochemical and behavioural state so that the effects of potential treatments can be clearly distinguished. Without this consideration, the quality of research and findings are undermined. Therefore, it is important for both aquaculture farmers and researchers to understand the effects of transfer on the stress and acclimation time of the fish.

POTENTIAL IMPACT

- Improved handling protocols for aquaculture farmers, leading to improved welfare of farmed European sea bass.
- Improved aquaculture experimental design, leading to higher quality results that can be implemented by the aquaculture industry.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 2 – Technology and Systems; Goal 4; Thematic Area 7 – Aquatic Animal Health and Welfare; Goal 4. To see the full list and descriptions of the thematic areas and goals, please visit: **bit.ly/3hBDpGH**

AQUAEXCEL2020 INNOVATIVE OUTPUT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

Two trials were conducted in which European sea bass were monitored over a period of several weeks after their transfer from cages to tanks. The effects were evaluated by close monitoring of biochemical, haematological, hormonal, behavioural and husbandry variables. The trials were performed on fish of two sizes: 150 g (small) and 300 g (large), to examine whether acclimation capacity is related to size. After transfer to the facilities, the small fish were randomly distributed in eight 500 L tanks, thus forming eight experimental groups. Subsequently, a group was chosen at random every week for growth and physiological parameter monitoring. Each group was only sampled once during the eight-week trial. The same procedure was used for the large fish.

RESULTS

- The results suggest that fish quickly attain physiological and behavioural normality, but require substantially longer acclimation time to fully adapt to the new conditions.
- All fish exhibited elevated post-transfer values of their hormonal, biochemical, and haematological variables. However, all variables reverted to their normal range by the end of the first week, irrespective of their size.
- The results suggest that smaller fish have higher capacity for adapting to the new conditions compared to their larger counterparts. Specifically, smaller fish reverted to normality 1 to 2 weeks earlier than larger fish with respect to husbandry parameters, and they also exhibited negligible mortalities.
- Regarding husbandry parameters, acclimation lasted 3 to 4 weeks for the small fish and 4 to 5 weeks for the large fish, with feed consumption generally low and conversion to biomass (Feed Conversion Ratio, FCR) exhibiting sub-optimal values during that time.
- Post-transfer fish showed signs of low swimming activity and preference for the lower parts of the tanks. However, for the majority of fish, this effect disappeared after a few days and, within the first two weeks, all fish resumed normal swimming behaviour irrespective of their size.
- The overall results of the trials suggest a minimum acclimation time of three weeks despite behavioural and physiological normality appearing to be achieved much faster (1 to 2 weeks post-transfer).

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Aquaculture researchers
APPLICATION: Use of longer acclimation periods to improve experimental methodology and therefore validity of results, leading to greater trust from industry.

END-USER 2: European sea bass producers
APPLICATION: Improved understanding of fish stress and response when subjected to transfer in addition to the effects of age on acclimatisation time, both of which could lead to improved welfare.

STATUS

Technology Readiness Level (TRL) 3 - experimental proof of concept

- Further research is needed to examine other parameters in the experiments, such as effect of temperature on acclimation time.

AT A GLANCE

TITLE: Effects of transfer from cages to tanks on European sea bass
KNOWLEDGE TYPE: Report
WHERE TO FIND IT: Contact details below
STATUS: Complete
TNA FACILITY USED: Hellenic Centre for Marine Research (HCMR), Greece
CONTACT DETAILS: Orestis Stavrakidis-Zachou (ostavrak@hcmr.gr), Nikos Papandroulakis (npap@hcmr.gr); HCMR, Greece
PATENTS OR OTHER IPR EXPLOITATIONS: No

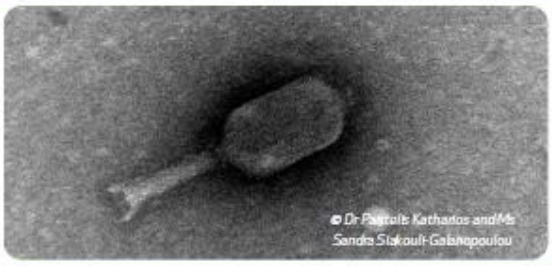
Designed and developed by AquaIT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This output reflects the views only of the author(s), and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

2.6 Administration of lytic bacteriophages to selectively decrease Vibrio spp. pathogens in aquaculture hatchery systems

ADMINISTRATION OF LYTIC BACTERIOPHAGES TO SELECTIVELY DECREASE *VIBRIO* SPP. PATHOGENS IN AQUACULTURE HATCHERY SYSTEMS

AQUA EXCEL 2020



SUMMARY

Phage therapy is the use of bacterial viruses, known as bacteriophages or phages, to selectively tackle potentially pathogenic bacteria prevalent in fragile systems such as aquaculture hatcheries. The use of biocontrol applications such as phage therapy is a promising area, and interest in the various practical applications, such as improved food and feed safety, has been gaining momentum. This research investigated the use of five bacteriophages together (two of which were previously characterised and three which were novel) to target the bacterial pathogens *Vibrio harveyi* and *Vibrio alginolyticus* in the aquaculture live feed, *Artemia salina*, as an alternative to antibiotics. The results showed that the administration of the bacteriophages had the potential to selectively decrease the populations of these *Vibrio* pathogens in the live feed.

KNOWLEDGE NEED

Bacterial diseases in aquaculture pose a serious problem for both the sustainability of production and the health and welfare of the fish. Vibriosis is one of the most common bacterial diseases in marine aquaculture hatcheries, typically caused by *Vibrio* bacteria entering larval rearing water through live feeds such as *Artemia* and rotifers. Traditionally, bacterial diseases such as vibriosis are treated with antibiotics, but overuse has led to concerns around antimicrobial resistance, environmental pollution and consumer health. Vaccines can also be used against vibriosis in later stages of fish growth, but this is not an effective strategy for larval stages. Alternative strategies to control bacterial infections are urgently needed and bacteriophages have shown potential as an effective method for biologically controlling potential outbreaks of *Vibrio* spp. in aquaculture systems. Research is in its early stages, and more information needs to be gathered, including efficacy, costs and efficiency.

UNDERLYING SCIENCE

Vibrio harveyi and *Vibrio alginolyticus* are prevalent in *Artemia salina* live feed cultures, and can use these as vehicles to infiltrate the hatchery systems, causing high mortality rates in the cultured species. Researchers isolated and characterized 5 lytic bacteriophages: St2 and Grn1 (isolated against *V. alginolyticus*), which were previously sequenced and characterized and VH2_DHL, DSM19623_DHL and V1_DHL (isolated against *V. harveyi* and *V. alginolyticus*), which have recently been isolated and sequenced. The efficacy of the phage cocktail consisting of the 5 lytic bacteriophages was first assessed *in vitro* against presumptive *Vibrio* colonies extracted from the *Artemia salina* live feeds. The phage cocktail was then deployed *in vivo* to the *Artemia salina* live feeds to selectively decrease the populations of *Vibrio harveyi* and *Vibrio alginolyticus*.

POTENTIAL IMPACT

- Healthier aquaculture environments due to selective targeting of potentially pathogenic bacteria while leaving the natural microbiota intact and not leaving any wastes in the ecosystem.
- A sustainable strategy to fight bacterial diseases and tackle antimicrobial resistance due to the level of specificity and the environmental origin of the viruses.
- Improved welfare of cultured fish.
- Improved understanding of the role of bacteriophages in tackling pathogenic bacteria.
- Supporting precaution before treatment in aquaculture health management.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 7- Aquatic Animal Health and Welfare; Goal 4. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 INNOVATIVE OUTPUT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

RESULTS

- The phage cocktail was able to inhibit *in vitro* presumptive vibrios in *Artemia salina* live feeds.
- The administration of lytic bacteriophages in *Artemia salina* live feeds selectively decreased the native populations of the opportunistic pathogens *Vibrio harveyi* and *V. alginolyticus*.
- Smaller volumes of live feed cultures led to better preliminary results because the increased multiplicity of infection seems to disinfect the live feed more efficiently.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Producers of lytic bacteriophages
APPLICATION: This research supports a demand for increased production of lytic bacteriophages to better manage pathogenic bacteria in aquaculture systems.

END-USER 2: Marine hatchery farmers and managers
APPLICATION: Aquaculture farmers could more sustainably manage pathogenic bacteria by using bacteriophages instead of antibiotics, tackling both waste in the environment and antimicrobial resistance.

END-USER 3: Producers of live aquaculture feeds
APPLICATION: As an alternative to antibiotic administration, producers of live aquaculture feeds could use bacteriophages to selectively remove bacterial pathogens in their feed.

END-USER 4: Marine microbiologists and fish pathologists
APPLICATION: The results highlight the potential use of lytic bacteriophages in treating pathogenic bacteria in an aquaculture environment.

END-USER 5: Consumers
APPLICATION: Consumption of safe fish products that have been produced in an antibiotic-free environment.

END-USER 6: Policy makers
APPLICATION: The results highlight that bacteriophage therapy is a potent alternative to antibiotics. Policy makers could use results such as these to define a clear legislatory path that will allow for the commercialization of phage therapy products while ensuring their safe use in the EU.

STATUS

Technology Readiness Level (TRL) 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies).

- The methodology needs to be more finely tuned (e.g. the quantity of bacteriophages), work is ongoing in this area.
- Further research is needed to ensure that up-scaled production of bacteriophages is purified from negative by-products (e.g. toxins) that may originate from the bacteriophage lysis events that occur during proliferation.
- The proliferation protocols for the bacteriophages need to be improved to maximise phage concentrations prior to phage therapy treatment.
- Trials are required to formulate a fully efficient phage cocktail (including research on its components in case of competitive interactions among the phages), and also to expand phage therapy trials against other bacterial targets.
- The output owner has participated in the setup of a new company (aquatic-biologicals.com), which will carry out more work on this topic at a commercial level.

AT A GLANCE

TITLE: Administration of lytic bacteriophages to selectively decrease *Vibrio* spp. pathogens in aquaculture hatchery systems
KNOWLEDGE TYPE: Exploitable scientific result
WHERE TO FIND IT: Contact details below
STATUS: The research is continuing
TNA FACILITY USED: Hellenic Center for Marine Research (HCMR), Greece
CONTACT DETAILS: Panagiotis Kalatzis, University of Copenhagen, Denmark; panos.kalatzis@bio.ku.dk
PATENTS OR OTHER IPR EXPLOITATIONS: N/A

Designed and developed by AquaIT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This output reflects the views only of the author(s), and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

2.7 Effect of a novel underwater robot on fish behaviour and welfare in sea cages

EFFECT OF A NOVEL UNDERWATER ROBOT ON FISH BEHAVIOUR AND WELFARE IN SEA CAGES

AQUA EXCEL 2020

SUMMARY

This output describes the effects of using a "turtle robot" (U-CAT) for surveillance in sea-based aquaculture farm cages, on the behaviour and welfare of the fish. The results showed that the U-CAT only negligibly stressed the fish, allowing close-up and clear footage of fish and sea cage conditions. In comparison, fish avoid intruding divers and commonly used thruster-driven underwater robots. This output will be of particular interest to aquaculture farmers, underwater robot producers, and researchers interested in monitoring fish behaviour.

KNOWLEDGE NEED

Monitoring of sea cages is important for aquaculture farmers to track the behaviour and welfare of their fish, and to assess the condition of cages. Human divers and underwater vehicles controlled by operators on land are typically used for this monitoring. Both types of intruders are costly, and disruptive and stressful for the fish. The usual underwater technology is propeller-driven, which is noisy and disruptive for the fish in the cages, making accurate monitoring difficult. There is a need for an alternative robot that can monitor fish in sea cages with minimal disturbance.

POTENTIAL IMPACT

- Improved underwater robot designs to provide more affordable, scalable and effective solutions for fish and sea cage monitoring.
- Robotic technology such as the U-CAT for surveillance allows continuous monitoring without interruption. This allows quicker responses, greater predictability, better fish welfare and lower mortality.
- Quick and efficient identification of damaged sea cages resulting in improved security and sustainability.
- Reduced need for human divers, leading to increased safety and welfare of aquaculture employees.
- Better understanding of best practice surveillance robots and the key characteristics they should have for effective and non-disruptive fish monitoring.
- Better public awareness of sustainable aquafarm management, and increased trust from consumers.
- Inspire advances in agriculture, environmental monitoring and animal health and welfare, where the use of animal-robot interactions can be applied.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 7- Aquatic Animal Health and Welfare; Goal 4.
To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 INNOVATIVE OUTPUT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

This study investigated if a small, bio-mimetic robot that moves slowly using soft flippers causes less stress to fish than commonly used, larger thruster-driven robots or human divers. Tallinn University of Technology (Estonia) developed a small and manoeuvrable "turtle" robot, called U-CAT - Underwater Curious Archaeology Turtle, which was originally designed for underwater archaeology and shipwreck investigations. U-CAT has a mechanical advantage over other commonly used underwater robots as it is highly mobile, and its flipper-driven system generates a weaker wake. It can use its fins to rotate around and it can get close to the sea cage and nets to take clear video shots. The U-CAT is capable of coping in underwater environments, including currents and waves. It was also investigated whether the colour and locomotion mode of the robot had an effect on the fish reaction. The U-CAT was tested on salmon (*Salmo salar*) and Scottish cleaner fish in sea cages.

RESULTS

The results show that the fish in cages remained closer to the U-CAT compared to the larger, thruster-driven robots more commonly used in commercial settings. However, it is not yet clear which aspect from the U-CAT's design causes the different behaviour response.

The study did not find conclusive evidence that the locomotion mode, colour, sound or speed of the U-CAT had a substantial effect on animal behaviour. The researchers conclude that the hydrodynamic or visual cues from different locomotion patterns and colours are not crucial design parameters. It could equally be that the decisive factors altering fish behaviour are more rudimentary cues, such as size and speed of the vehicle. The robot's turtle-like appearance doesn't seem to play any role, meaning robot designs can take other forms. The results also show that both small and large underwater robots disturbed fish much less than a human diver. Results from this study highlighted that the standard inspection procedure by commercial divers is highly disturbing for the fish, removing the opportunity to observe fish in their natural state.

END-USERS & POTENTIAL APPLICATIONS

- **END-USER 1: Aquaculture farmers**
  APPLICATION: Improved monitoring of health, welfare and behaviour of fish in sea cages, as well as the condition of the sea cages.
- **END-USER 2: Technology producers**
  APPLICATION: Improved knowledge about new technological solutions for monitoring e.g. sea cages, fish in cages, climate threats etc. on the aquaculture sector.
- **END-USER 3: Aquaculture researchers**
  APPLICATION: Monitoring of fish with minimal disturbance to better understand fish behaviour.
- **END-USER 4: Aquaculture marketing and lobby groups**
  APPLICATION: Use of robots to monitor fish in sea cages allows for improved welfare of the fish, thus helping to improve the public perception of aquaculture.

STATUS

Technology Readiness Level (TRL) 6 - technology demonstrated in relevant environment.

- The U-CAT is a handmade prototype and has been verified through testing. There are currently two U-CAT robots, developed by the Tallinn University of Technology, Estonia
- The U-CAT is currently used by researchers for field work.
- The U-CAT has several sensors and could be tailored for end-user requirements.

AT A GLANCE

TITLE: Effect of a novel underwater robot on fish behaviour and welfare in sea cages
KNOWLEDGE TYPE: Exploitable scientific result
WHERE TO FIND IT: Contact details below
STATUS: Published in *Royal Society Open Science*. DOI:10.1098/rsos.191220
TNA FACILITY USED: SINTEF ACE, Norway
CONTACT DETAILS: Maarja Kruusmaa, maarja.kruusmaa@taltech.ee; Asko Ristolainen, asko.ristolainen@taltech.ee. Tallinn University of Technology, Estonia
PATENTS OR OTHER IPR EXPLOITATIONS: IP belongs to Tallinn University of Technology, Estonia

Designed and developed by AquaIT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This output reflects the views only of the author(s), and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

2.8 Physiological and behavioural effects of handling procedures on Atlantic salmon

PHYSIOLOGICAL AND BEHAVIOURAL EFFECTS OF HANDLING PROCEDURES ON ATLANTIC SALMON

SUMMARY

This output concerns information on the effects of handling procedures (pumping and netting) and use of sedation on the acclimation time and stress of farmed Atlantic salmon (*Salmo salar*). By improving the protocols for handling fish during transfer activities, welfare can be improved on fish farms, and researchers' experimental methodology can be more robust and tailored for implementation.

KNOWLEDGE NEED

Handling of fish is necessary, both in commercial farming operations and in research facilities, but causes stress and discomfort for the fish. The acclimation time – the time for the fish to resume normal physiology and behaviour – will depend on the severity of the stress experienced by the fish. An important consideration when conducting fish experiments *in vivo* is the use of animals that are in a stable physiological, biochemical and behavioural state so that the effects of potential treatments can be clearly distinguished. Without this consideration, the quality of research and findings are undermined. Therefore, it is important for both aquaculture farmers and researchers to understand the effects of handling on the stress and acclimation time of the fish.

POTENTIAL IMPACT

- Improved experimental methodology leading to higher-quality results that are implemented by the aquaculture industry.
- Improved handling protocols for aquaculture farmers, leading to improved welfare of farmed Atlantic salmon.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 7 – Aquatic Animal Health and Welfare; Goal 3, Goal 4; Thematic Area 6 - Knowledge Management; Goal 4. To see the full list and descriptions of the thematic areas and goals, please visit: **bit.ly/3hBDpGH**

AQUAEXCEL2020 INNOVATIVE OUTPUT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

An experiment was performed with a 2 x 2 factorial design, incorporating the variables of handling procedure (pumping or netting) and sedation/no sedation. Atlantic salmon smolts were pumped or netted from 4 large tanks (3.3 m³) with water salinity 12 ppt, to 12 smaller tanks (0.5 m³) with water salinity of 32 ppt, where they stayed for a period of 30 days. To measure both the acute stress responses and longer-term effects, samples of blood, skin and gills were taken before transfer and at regular intervals after transfer. The samples were analysed for plasma cortisol, blood glucose and lactate, serum ion concentrations, skin histology and gene expression. Fish welfare and growth rate were also assessed. Feed intake was measured daily, both in the large and small tanks for the 30-day trial period, to assess if handling method affected the time to resume normal feed intake.

RESULTS

- When assessing the primary, secondary and tertiary stress response, there were no large differences observed between using pumping or netting for transfer of Atlantic salmon smolts between indoor tanks.
- Feed intake resumed to pre-handling levels within five days in all treatment groups, but it took a few days longer to feed normally for the pumped fish. During the 30-day trial, there were no significant effects of handling method or sedation on feed intake and growth.
- Compared to not using sedation, sedated fish had better skin health as assessed by histology, gene expression and visual assessment, for both transfer processes. This is most likely due to sedated fish being calm during transfer.
- Sedation reduced plasma cortisol, blood lactate and plasma ions shortly after handling. However, there was a delayed increase in plasma cortisol in sedated fish 24 hours after handling.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Aquaculture researchers
APPLICATION: Improved experimental methodology, leading to transfer of higher quality results to industry for implementation.

END-USER 2: Atlantic salmon farmers
APPLICATION: Implementation of improved protocols in standard operating procedures means fish farmers will reduce the negative (and costly) consequences of stress-inducing and potentially harmful transfer activities.

STATUS

- The results are in the process of being published.
- Together with previous work on handling procedures the topic will continue to be a focus area and highly relevant as part of the development of new farming procedures and technologies.

AT A GLANCE

TITLE: Physiological and behavioural effects of handling procedures on Atlantic salmon
KNOWLEDGE TYPE: Report
WHERE TO FIND IT: Contact details below
STATUS: Complete
TNA FACILITY USED: Nofima, Norway
CONTACT DETAILS: Åsa Espmark; asa.espmark@nofima.no; Nofima, Norway
PATENTS OR OTHER IPR EXPLOITATIONS: No

Designed and developed by AquaTT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This output reflects the views only of the author(s), and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

2.9 Parentage assignment in meagre

PARENTAGE ASSIGNMENT IN MEAGRE

SUMMARY

This output describes the first successful parentage assignment in meagre at an industrial scale production system - over 90% on average. The results support the development of novel genetic approaches for meagre, to identify genomic regions associated with differential growth. This could lead to a more sustainable breeding programme with less variability in size and growth in farmed meagre.

KNOWLEDGE NEED

Meagre (*Argyrosomus regius*) is a relatively newly farmed species with great potential in large-scale European aquaculture. One of the major hurdles in successfully establishing a fish industry is variability in growth of farmed fish of the same age. Reducing variables such as these has thus become a highly desirable objective in fish breeding programmes.

POTENTIAL IMPACT

The aquaculture industry is expected to benefit from this first description of parentage in meagre production, particularly in the following ways:

- A genetic tool (a ten-microsatellite loci multiplex) is described, and can be used to assess the genetic variability and parentage assignment in the species.
- Less variability in size and growth leading to a more profitable meagre farming sector.
- Assistance with the identification of genomic regions associated with differential growth in the species, which will provide the necessary tools for marker-assisted and genomic selection.
- Development of a successful breeding programme for meagre to produce same-sized fish.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 3 - Managing the Biological Lifecycle; Goal 2. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 INNOVATIVE OUTPUT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

A total of 800 meagre fish were sampled from two large cages in January and May 2016, both part of a commercial farm site in Valencia, Spain. All fish originated from the same spawning event obtained from a broodstock of 6 females and 13 males. However, due to differential growth during the juvenile stage, the fish were graded into two groups. A group of larger juveniles was transferred to one cage (batch 1) and a group of smaller juveniles was transferred to a second cage (batch 2). Heritability estimates for body weight and total body length were calculated, as well as the genetic correlation estimates for these two traits.

RESULTS

- Successful parentage assignment using the multiplex tool was 91 % for both batches analysed.
- Female and male broodstock do not contribute equally to offspring; this is also the same for fish injected with gonadotropin-releasing hormone agonists (GnRHA) and those that weren't.
- It was established that heritability estimates for body weight and total body length were different in the offspring of the different families that were analysed. Batch 1 showed higher heritability estimates than batch 2. Genetic correlation estimates were almost the same for both batches.
- Results indicate that, among the fifteen shared families in the two batches, there is some substantial, statistically significant, variation within families, with three families showing variation for weight and two for length.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Aquaculture geneticists
APPLICATION: The results of this research will provide useful indications of novel future approaches concerning Quantitative Trait Locus (QTL) research for growth-related traits in meagre.

END-USER 2: Meagre farmers
APPLICATION: In the future, the identification of genomic regions associated with differential growth in the species will provide the necessary tools for marker assisted and genomic selection. Farmers can then produce same-age meagre with less variability in size.

STATUS

Technology Readiness Level (TRL) 2 – technology concept formulated

- A genetic linkage map for the species will soon be available, resulting from the application of the ddRAD (double-digest Random Amplified DNA) methodology on fish from selected families reported in the corresponding published paper (details below). The construction of a high-quality linkage map and future mapping of trait-related quantitative trait loci (QTL) is required as a foundation for implementation of Marker Assisted Selection (MAS) in any species.

AT A GLANCE

TITLE: Parentage assignment in meagre
KNOWLEDGE TYPE: Scientific publication
WHERE TO FIND IT: Nousias, *et al.* (2020). Parentage assignment, estimates of heritability and genetic correlation for growth-related traits in meagre *Argyrosomus regius*. *Aquaculture* 518;734663. DOI: 10.1016/J.aquaculture.2019.734663
STATUS: Published. More research in this area is required.
TNA FACILITY USED: "Omics-BioInfo", Hellenic Centre for Marine Research (HCMR), Crete, Greece
CONTACT DETAILS: Costas Tsigenopoulos, Hellenic Centre for Marine Research, Greece, tsigeno@hcmr.gr
PATENTS OR OTHER IPR EXPLOITATIONS: No

Designed and developed by AquaTT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This output reflects the views only of the author(s), and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

Annex 3: Webinar OUTPUT Presentation PowerPoint slides (4)

OUTPUT presentation #1: Black soldier fly meal in pikeperch feeds (Laura Gasco)

OUTPUT presentation #2: LSAqua protein source for rainbow trout (*Oncorhynchus mykiss*) diets (Paula Solé Jiménez)

OUTPUT presentation #3: Novel sensors to measure distributed flow in aquaculture sea cages (Asko Ristolainen)

OUTPUT presentation #4: Improving salmon feeding process with the Smart System for Feeding Control (SICA) (Rosa Martinez Alvarez-Castellanos)

Annex 4: Questions from the webinar Q&A and Chat boxes

Webinar 1: Aquafeed of the Future
Chat box transcript

Aquafeed of the Future | 30th October 10-12 CET

Webinar 1: Aquafeed of the Future
Q&A box questions asked

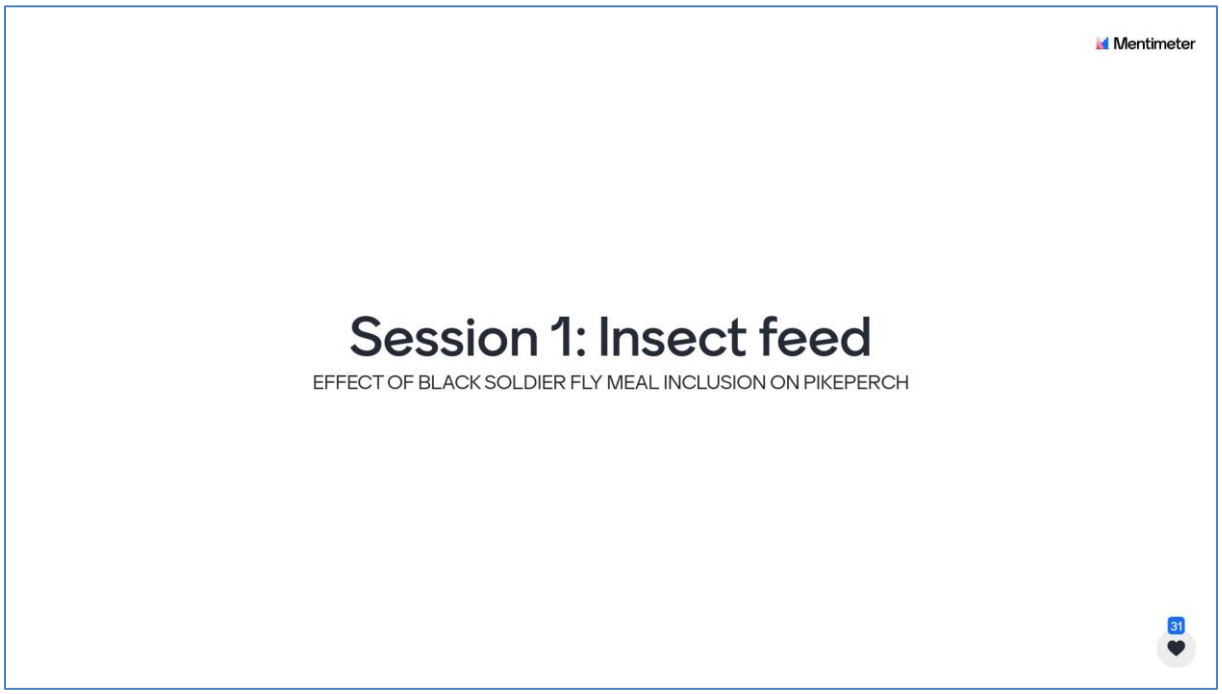
Webinar 2: Innovations to Support Fish Welfare
Chat box transcript

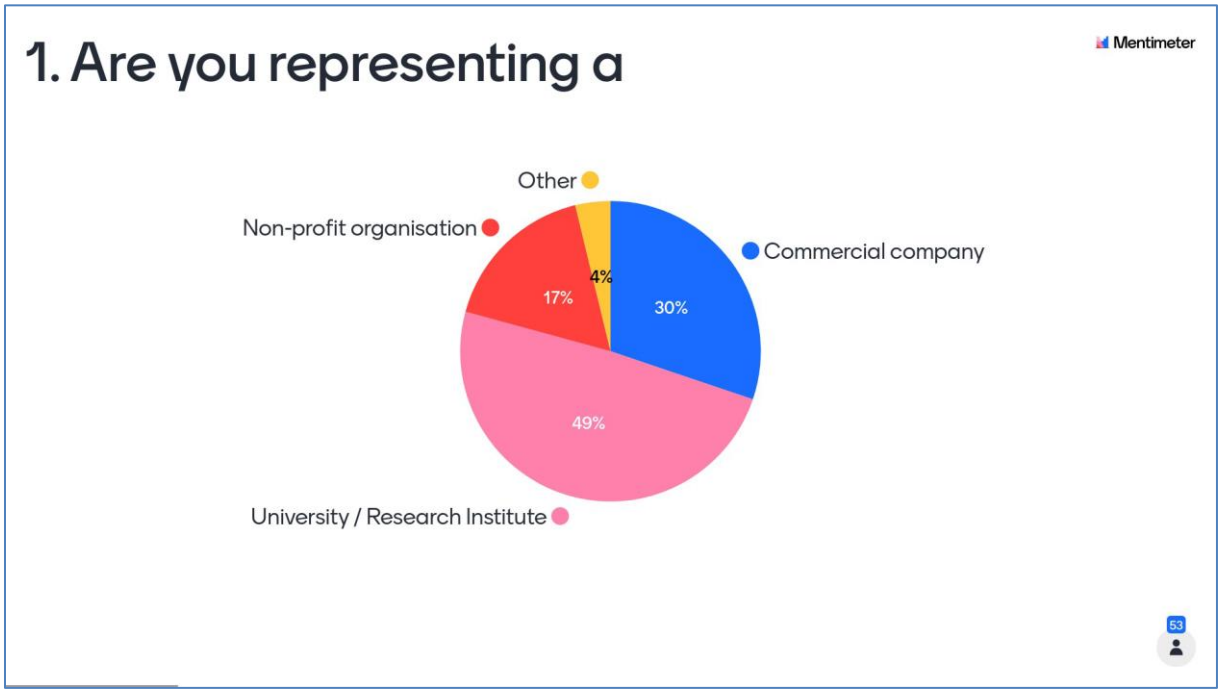
Innovations to Support Fish Welfare – CHAT | 25 Nov 10:00h – 12:00h CET

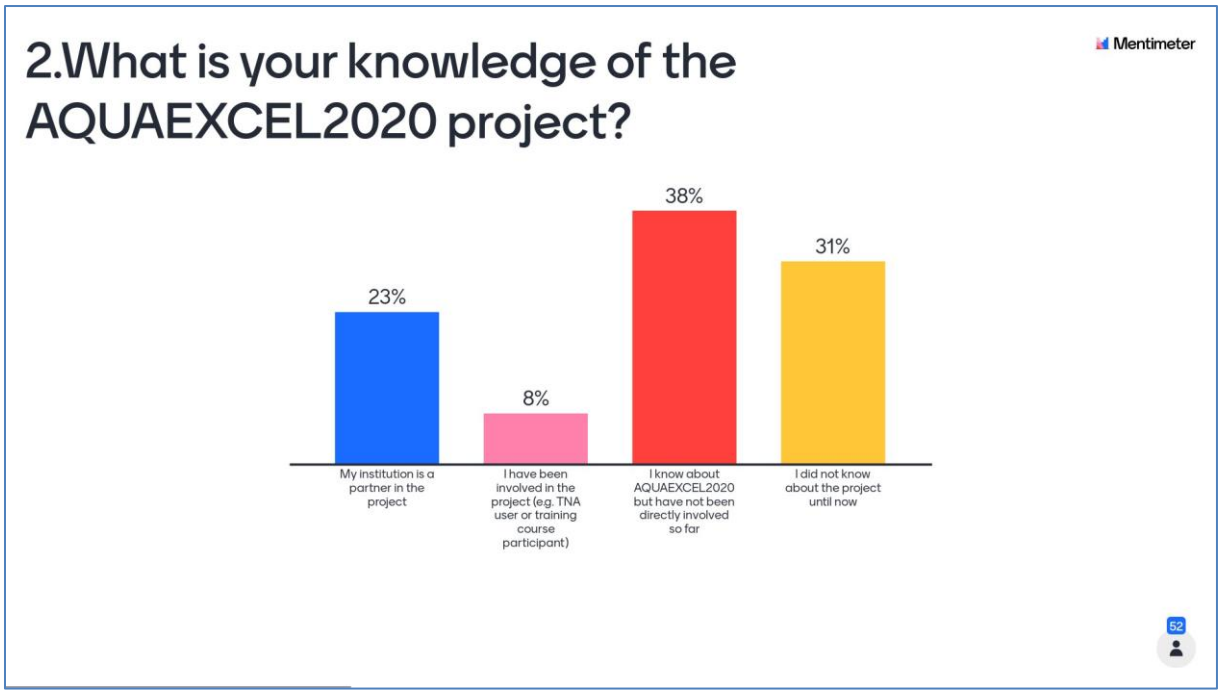
Webinar 2: Innovations to Support Fish Welfare
Q&A box: questions asked

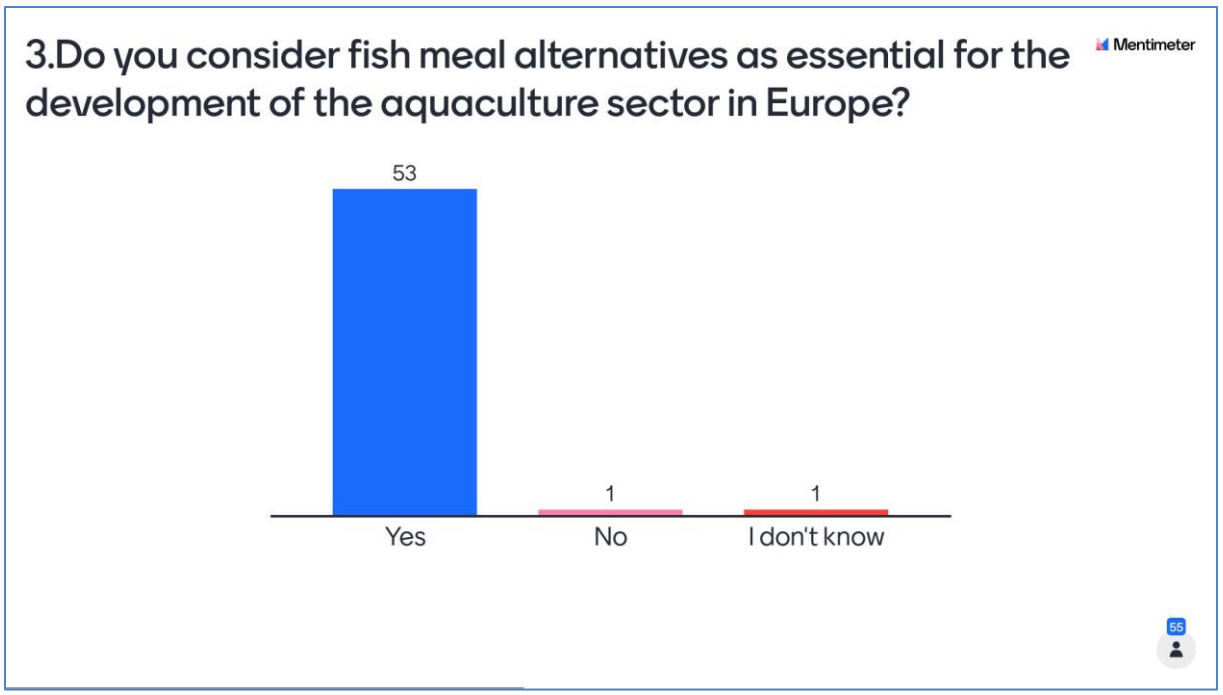
Annex 5: Mentimeter sessions

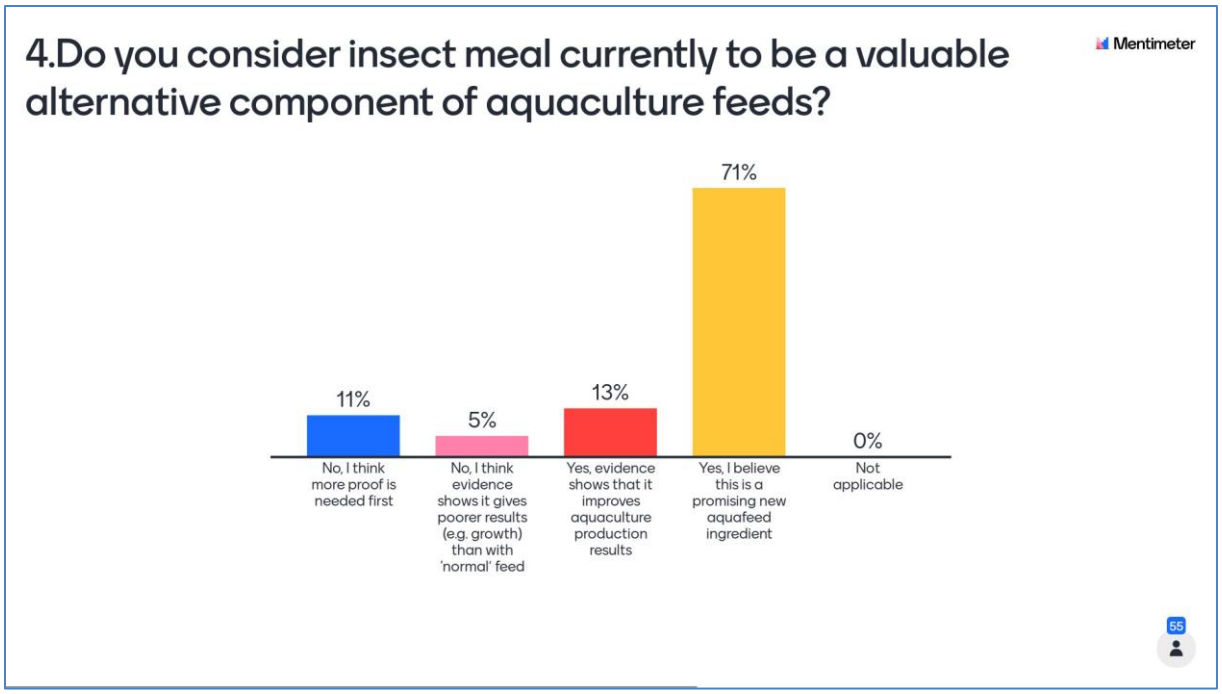
1. Aquafeed of the Future; Session 1 (Insect Feed)

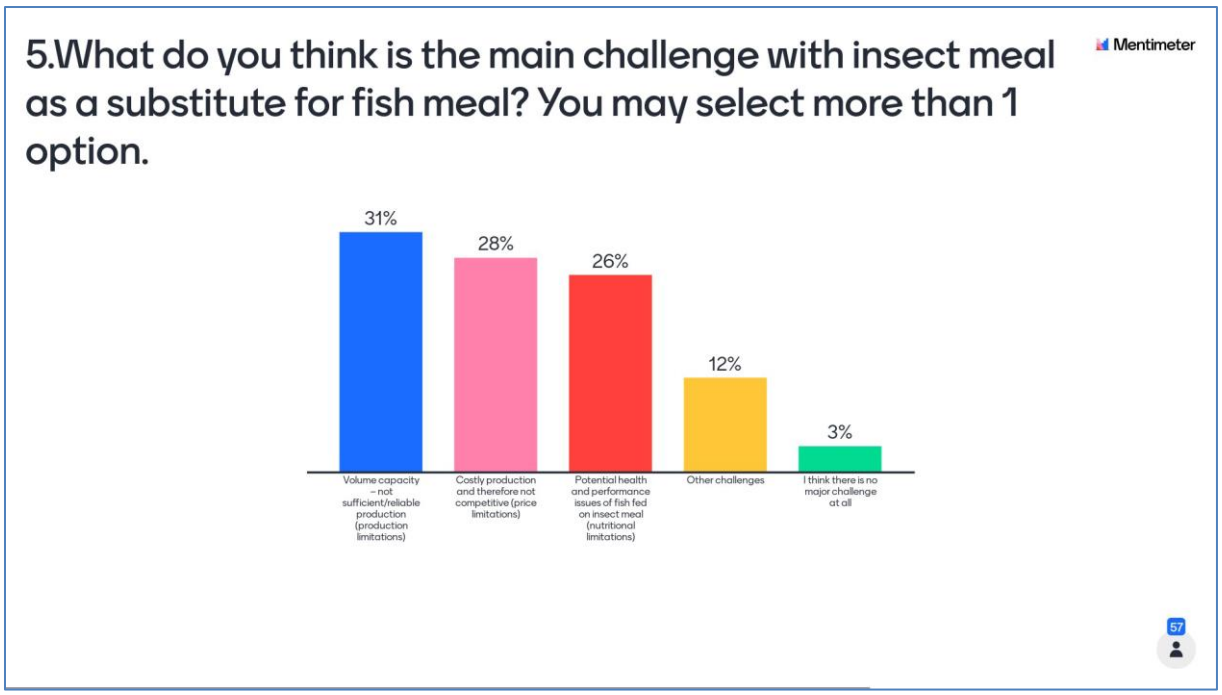


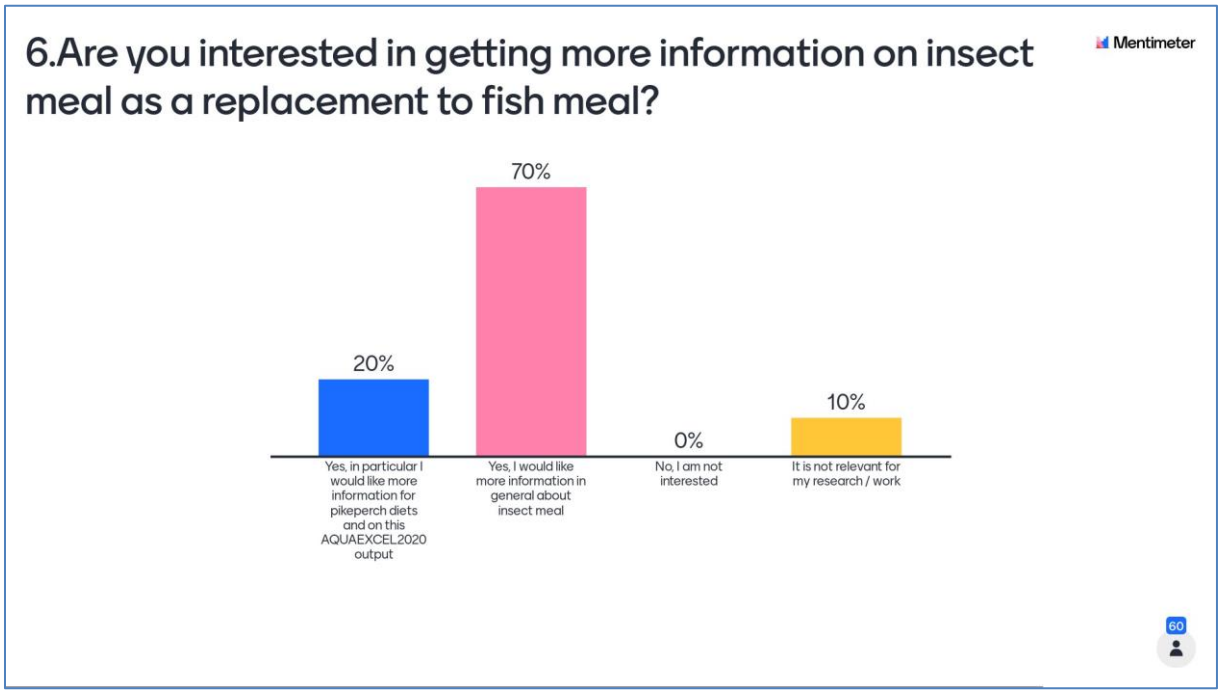


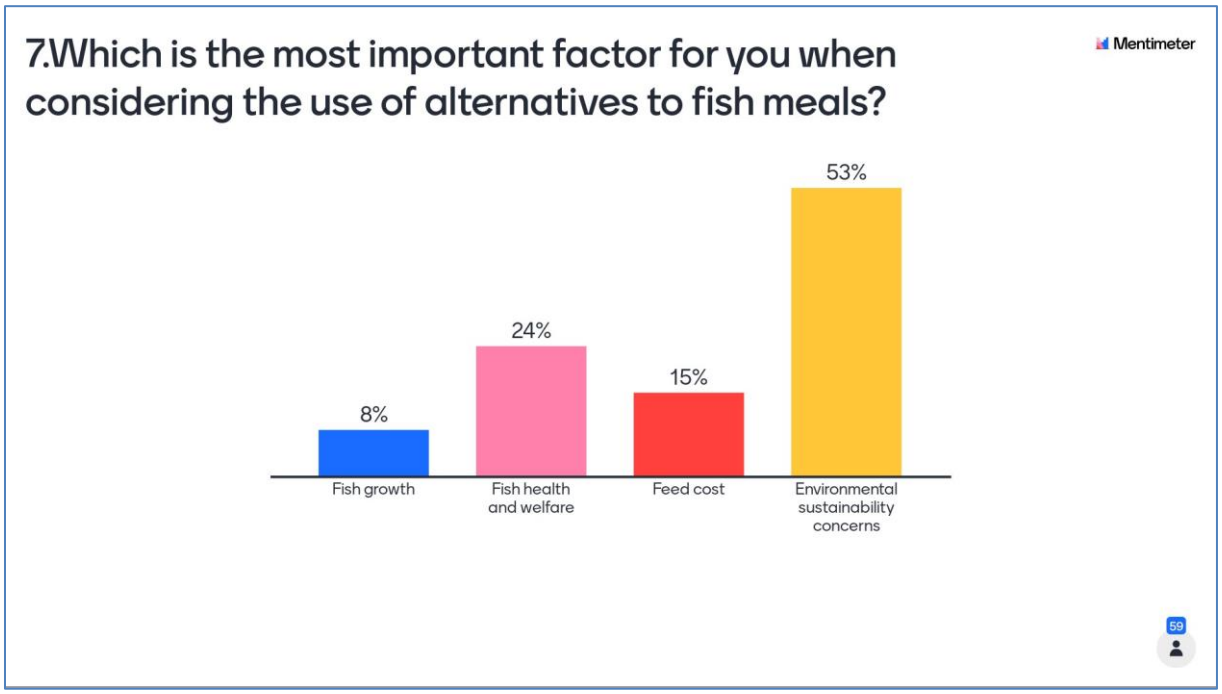

2.What is your knowledge of the AQUAEXCEL2020 project?
Mentimeter
23%
8%
38%
31%
My institution is a partner in the project
I have been involved in the project (eg. TNA user or training course participant)
I know about AQUAEXCEL2020 but have not been directly involved so far
I did not know about the project until now
52


3.Do you consider fish meal alternatives as essential for the development of the aquaculture sector in Europe?
Mentimeter
53
1
1
Yes
No
I don't know
55

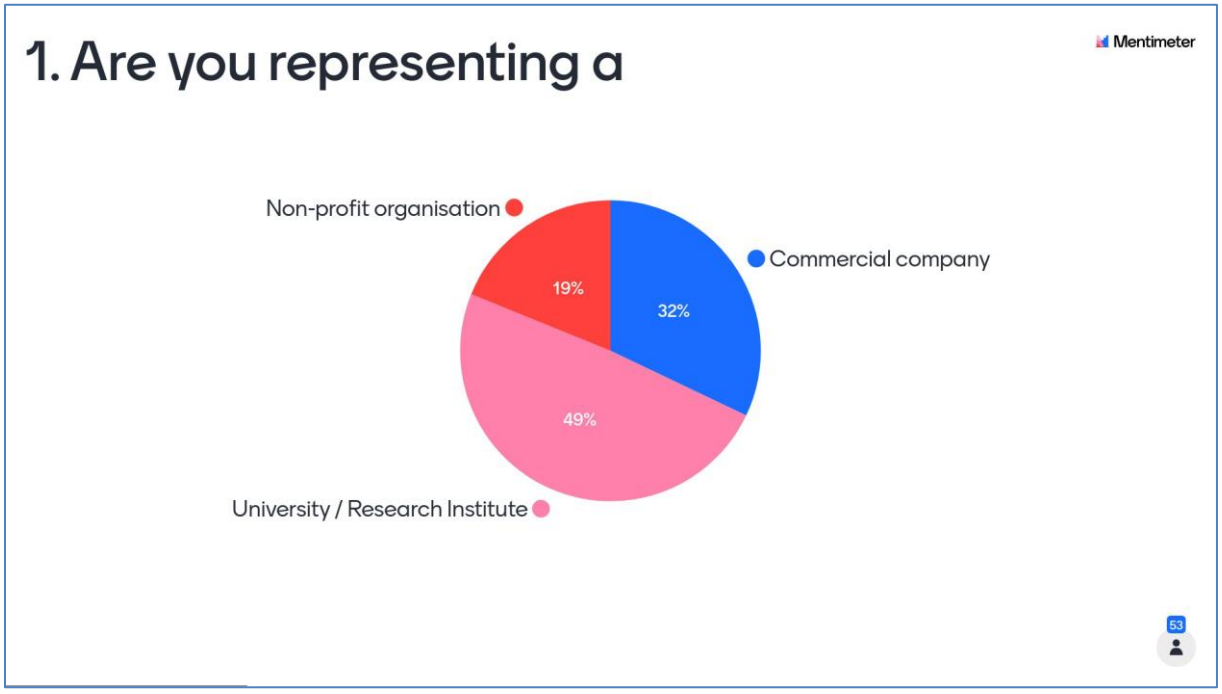

4.Do you consider insect meal currently to be a valuable alternative component of aquaculture feeds?
Mentimeter
11%
5%
13%
71%
0%
No, I think more proof is needed first
No, I think evidence shows it gives poorer results (e.g. growth) than with 'normal' feed
Yes, evidence shows that it improves aquaculture production results
Yes, I believe this is a promising new aquafeed ingredient
Not applicable
55

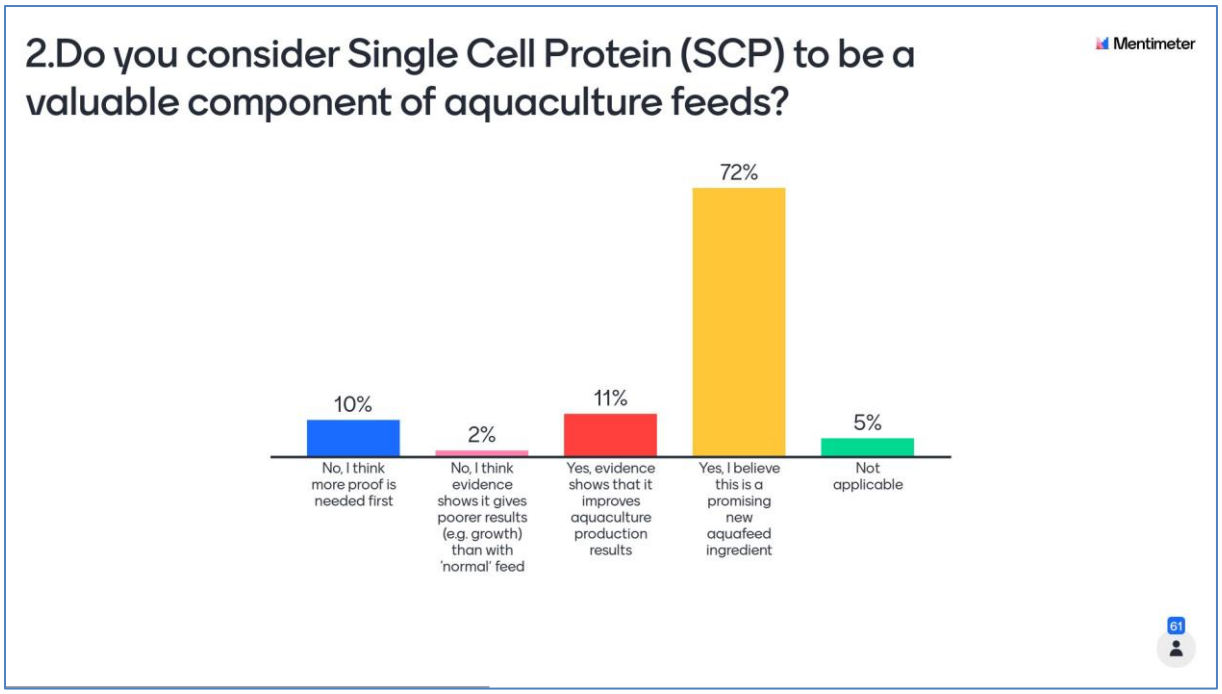

5.What do you think is the main challenge with insect meal as a substitute for fish meal? You may select more than 1 option.
Mentimeter
31%
28%
26%
12%
3%
Volume capacity – not sufficient/reliable production (production limitations)
Costly production and therefore not competitive (price limitations)
Potential health and performance issues of fish fed on insect meal (nutritional limitations)
Other challenges
I think there is no major challenge at all
57

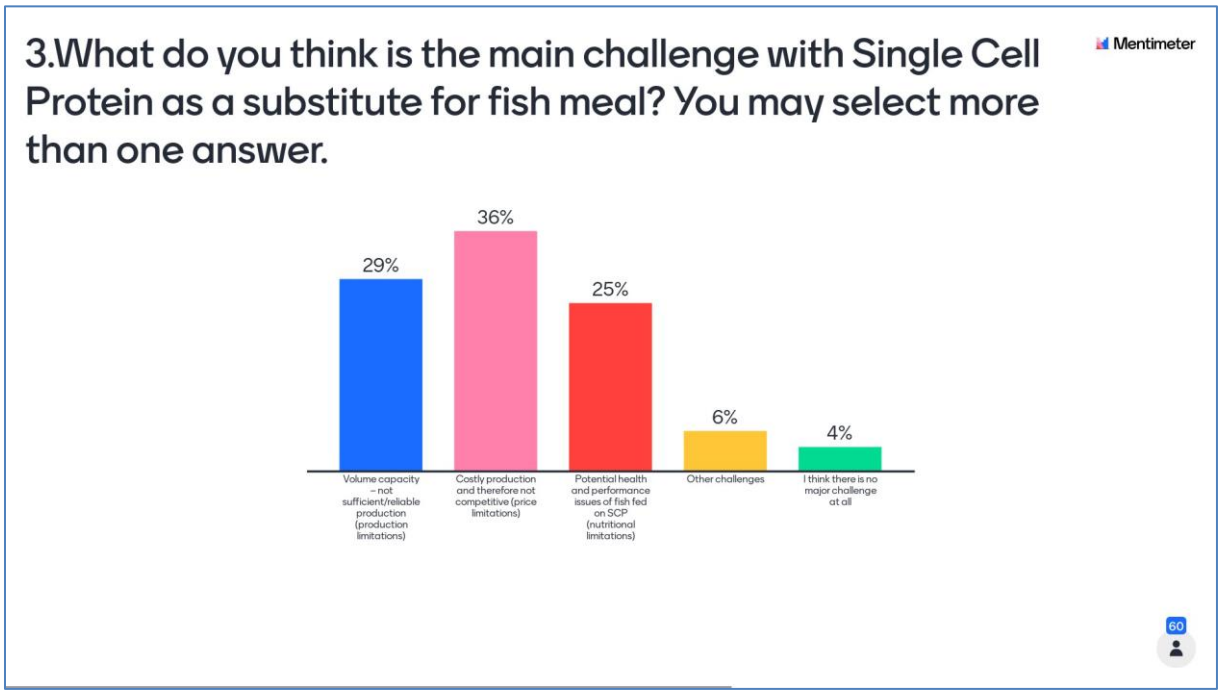

6.Are you interested in getting more information on insect meal as a replacement to fish meal?
Mentimeter
20%
70%
0%
10%
Yes, in particular I would like more information for pikeperch diets and on this AQUAEXCEL2020 output
Yes, I would like more information in general about insect meal
No, I am not interested
It is not relevant for my research / work
60

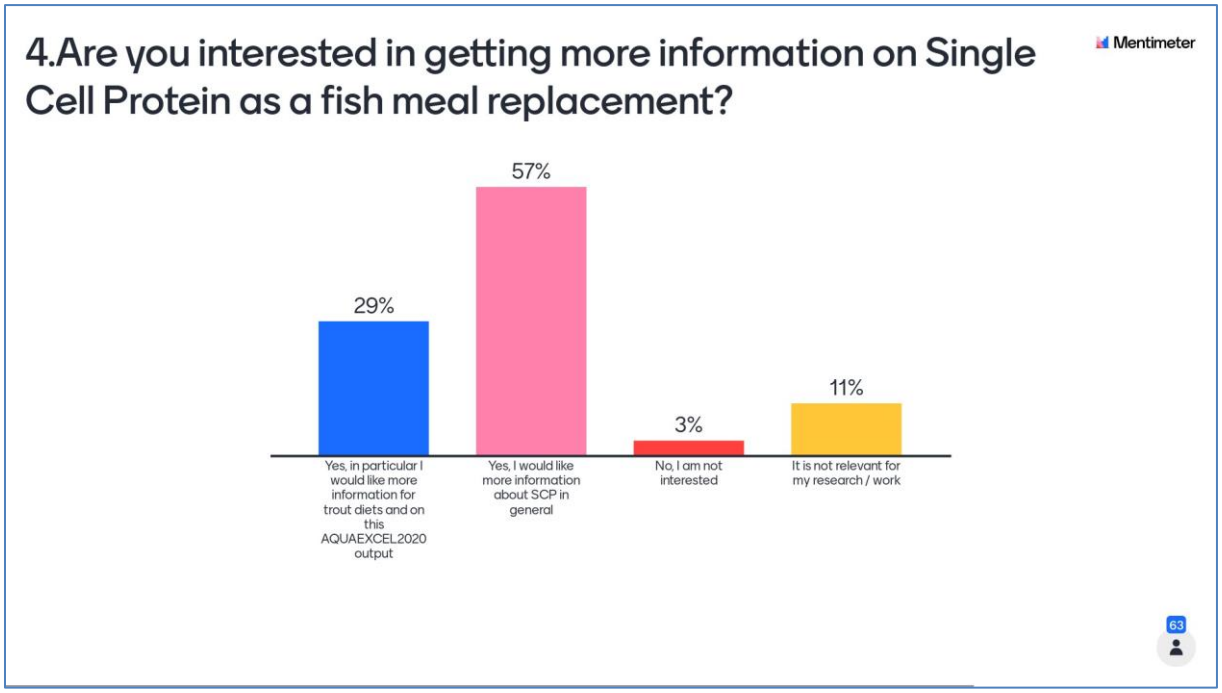

7.Which is the most important factor for you when considering the use of alternatives to fish meals?
Mentimeter
8%
24%
15%
53%
Fish growth
Fish health and welfare
Feed cost
Environmental sustainability concerns
59

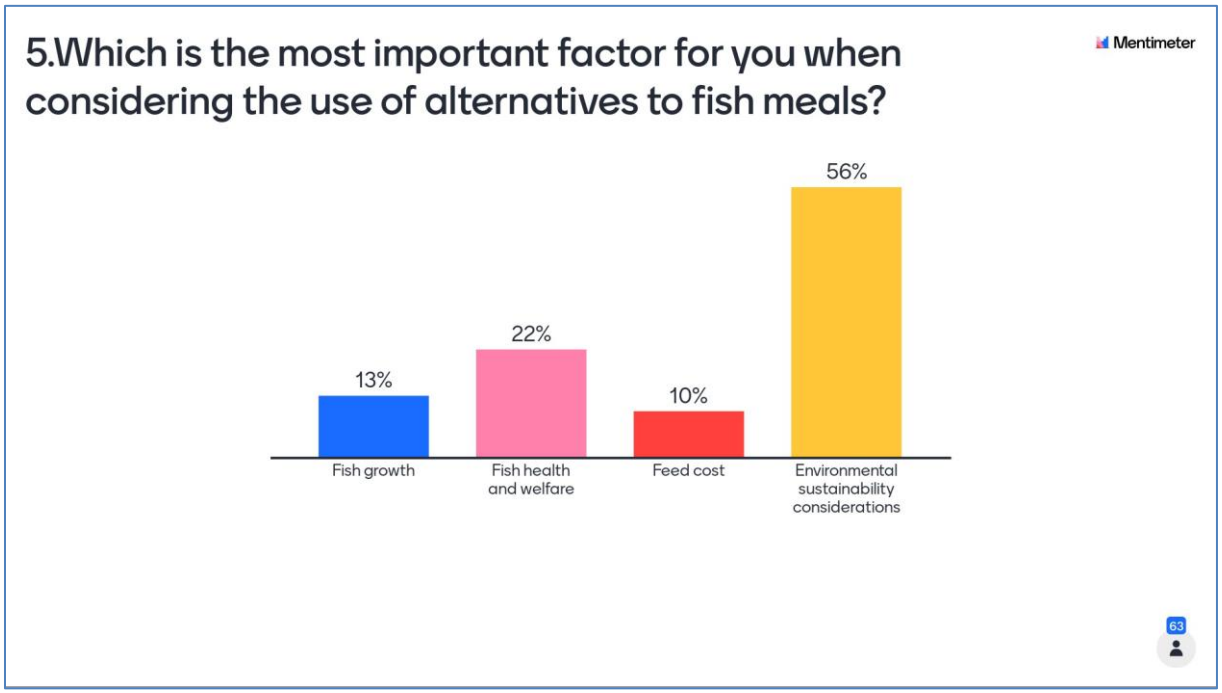
2. Aquafeed of the Future; Session 2 (Single Cell Protein)




2.Do you consider Single Cell Protein (SCP) to be a valuable component of aquaculture feeds?
Mentimeter
10%
2%
11%
72%
5%
No, I think more proof is needed first
No, I think evidence shows it gives poorer results (e.g. growth) than with 'normal' feed
Yes, evidence shows that it improves aquaculture production results
Yes, I believe this is a promising new aquafeed ingredient
Not applicable
61


3.What do you think is the main challenge with Single Cell Protein as a substitute for fish meal? You may select more than one answer.
Mentimeter
29%
36%
25%
6%
4%
Volume capacity - not sufficient/reliable production (production limitations)
Costly production and therefore not competitive (price limitations)
Potential health and performance issues of fish fed on SCP (nutritional limitations)
Other challenges
I think there is no major challenge at all
60


4.Are you interested in getting more information on Single Cell Protein as a fish meal replacement?
Mentimeter
29%
57%
3%
11%
Yes, in particular I would like more information for trout diets and on this AQUAEXCEL2020 output
Yes, I would like more information about SCP in general
No, I am not interested
It is not relevant for my research / work
63


5.Which is the most important factor for you when considering the use of alternatives to fish meals?
Mentimeter
13%
22%
10%
56%
Fish growth
Fish health and welfare
Feed cost
Environmental sustainability considerations
63

3. Innovations to Support Fish Welfare; Session 1 (Novel sensors)

Mentimeter

Session 1: Novel sensors to measure distributed flow in aquaculture sea cages

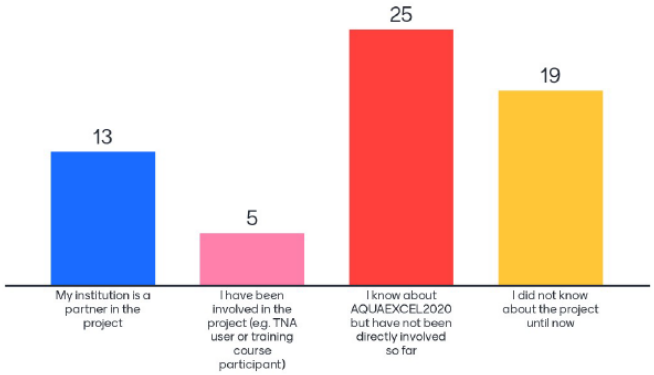
Mentimeter

1. Are you representing a

55

2. What is your knowledge of the AQUAEXCEL2020 project?

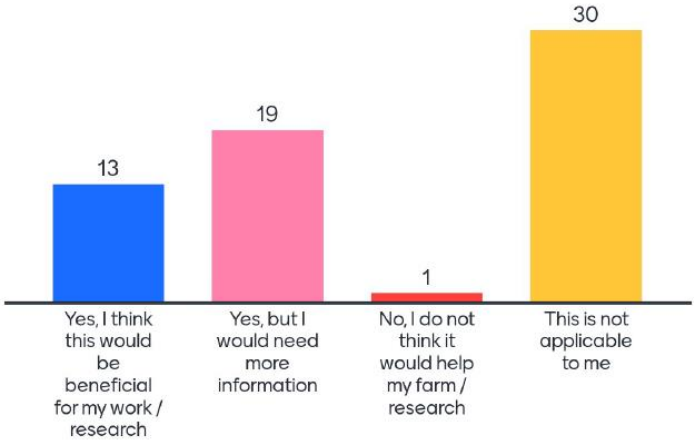
Mentimeter



62

3. If the novel sensors were available for purchase, would you be interested in using them?

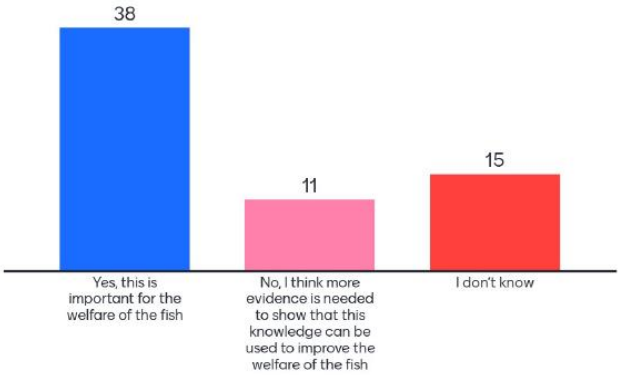
Mentimeter



63

4. Do you consider this type of distributed flow monitoring through offshore aquaculture cages to be important to ensure fish welfare?

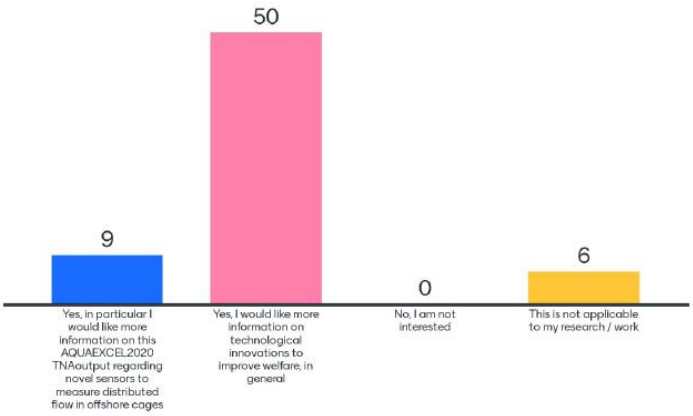
Mentimeter



64

5. Are you interested in getting more information on technological innovations to improve fish welfare?

Mentimeter



65

4. Innovations to Support Fish Welfare; Session 2 (SICA)

Mentimeter

Session 2: Improving Atlantic salmon feeding process efficiency with the Smart System for Feeding Control (SICA)

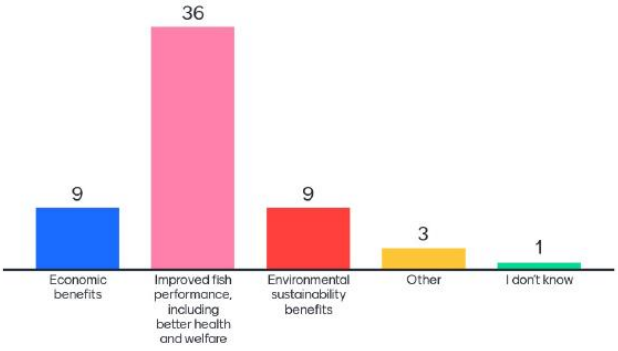
Mentimeter

1. Are you representing a

55

2. In your opinion, what is the most important factor when considering the use of new technological solutions in aquaculture?

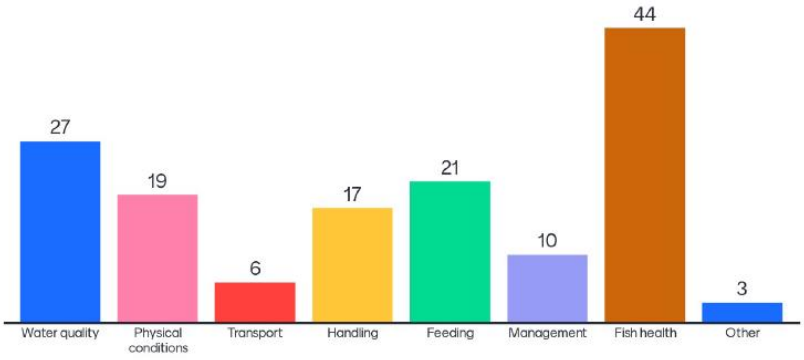
Mentimeter



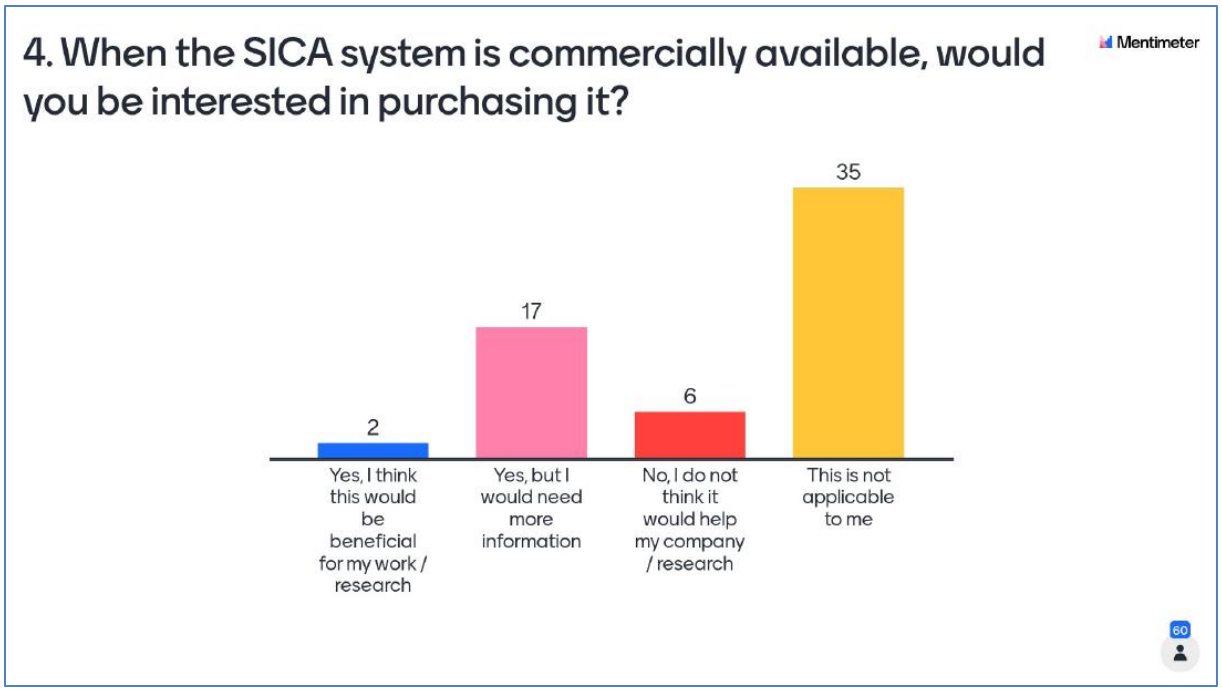
58

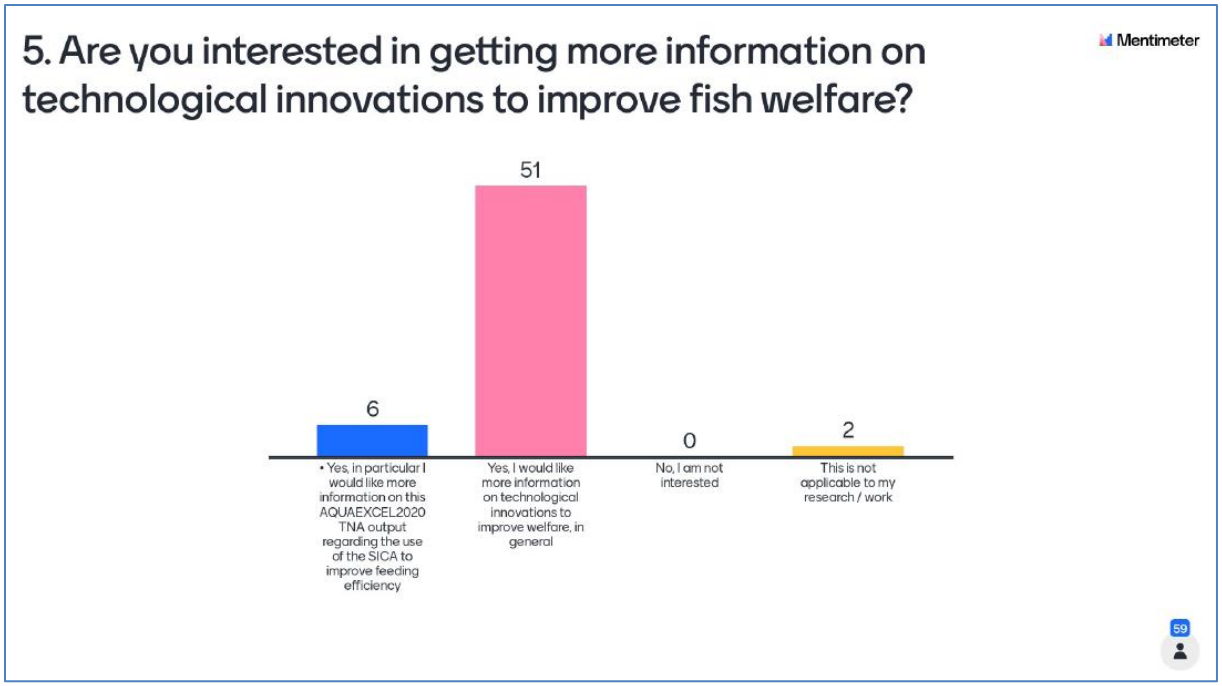
3What do you consider the most important fish welfare area that should be addressed using innovative solutions and new technologies? (Up to 3 answers)

Mentimeter



57


4. When the SICA system is commercially available, would you be interested in purchasing it?
Mentimeter
35
17
6
2
Yes, I think this would be beneficial for my work / research
Yes, but I would need more information
No, I do not think it would help my company / research
This is not applicable to me
60


5. Are you interested in getting more information on technological innovations to improve fish welfare?
Mentimeter
51
6
0
2
• Yes, in particular I would like more information on this AQUAEXCEL2020 TNA output regarding the use of the SICA to improve feeding efficiency
Yes, I would like more information on technological innovations to improve welfare, in general
No, I am not interested
This is not applicable to my research / work
59

Annex 6: Registered participants' organisation names

List of organisations from which people registered to attend Webinar 1: Aquafeed of the Future

List of organisations from which people registered to attend Webinar 2: Innovations to support fish welfare

Annex 7: Check list

Deliverable Check list (to be checked by the "Deliverable leader")

	Check list		Comments
BEFORE	I have checked the due date and have planned completion in due time		*Please inform Management Team of any foreseen delays*
	The title corresponds to the title in the DOW		*If not please inform the Management Team with justification*
	The dissemination level corresponds to that indicated in the DOW		
	The contributors (authors) correspond to those indicated in the DOW		
	The Table of Contents has been validated with the Activity Leader		*Please validate the Table of Content with your Activity Leader before drafting the deliverable*
	I am using the AQUAEXCEL2020 deliverable template (title page, styles etc)		*Available in "Useful Documents" on the collaborative workspace*
The draft is ready			
AFTER	I have written a good summary at the beginning of the Deliverable		*A 1-2 pages maximum summary is mandatory (not formal but informative on the content of the Deliverable)*
	The deliverable has been reviewed by all contributors (authors)		*Make sure all contributors have reviewed and approved the final version of the deliverable. You should leave sufficient time for this validation.*
	I have done a spell check and had the English verified		
	I have sent the final version to the WP Leader, to the 2nd Reviewer and to the Project coordinator (cc to the project manager) for approval		*Send the final draft to your WP Leader, the 2nd Reviewer and the coordinator with cc to the project manager on the 1st day of the due month and leave 2 weeks for feedback. Inform the reviewers of the changes (if any) you have made to address their comments. Once validated by the 2 reviewers and the coordinator, send the final version to the Project Manager who will then submit it to the EC.*