AQUACULTURE PILOT PROJECTS IN THE ATLANTIC AREA REGION

PROJECT IDENTIFICATION: EAPA_1059/2018 – ACCESS2SEA

PILOT ACTION 4. AQUACULTURE ACTIVITIES SOCIAL ACCEPTANCE

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OVERVIEW

Aquaculture innovation has a key role to play in the success of blue growth and sustainability, contributing to competitiveness, resource efficiency, job creation, as well as protecting and providing services to marine and coastal ecosystems. The aquaculture industry is looking for alternatives that promote economically profitable farming with a very low environmental footprint, committed to animal welfare and nutritional quality of the product. Access2Sea project is compromised with these targets and besides is improving accessibility to the marine space, supporting SME to boost business models and elaborating innovative tools or methodologies.

Access2Sea's project count on four areas of intervention to boost aquaculture SME's: **Social Acceptance**, **Spatial Planning**, **sustainable Business Models** and, in parallel, **Pilot Projects** developed with the purpose of materialising the results obtained throughout the project execution.

Pilots projects have been developed to answer to the key fields of the project: (1) **Improve the social acceptance of those activities**; (2) **Support the sustainable aquaculture activities** (new and existing) **and spatial planning**; (3) **Take advantage of business opportunities detected**.

Each pilot action carried out during the project execution were previously framed in these three main objectives: Pilot action 1, New aquaculture sites, satisfied the necessities observed in (2). Pilot action 2, aquaculture activities installation, was framed as part of (3) in addition to Pilot action 5, Feed intake simulation model. Pilot action 3, sustainable aquaculture, and **Pilot action 4, social acceptance activities**, were developed in the context of (1).

PILOT ACTION 4: Aquaculture activities social acceptance

1. INTRODUCTION

Fish welfare is a controversial topic which is impacting the social acceptability of salmon farming. Every year 50 million lumpfish are deployed in salmon cages to eat sea lice - a parasite that feeds on the skin of Atlantic salmon. Consumers and retailers generally support the use of cleaner fish to control sea lice but only if the welfare of lumpfish is not compromised.

This pilot created the lumpfish Welfare watcher a tool that allows fish farmers to monitor and record the welfare of lumpfish and take remedial actions.

IMPLEMENTATION SUMMARY

CSAR researchers developed and validated a rapid Lumpfish Operational Welfare Score Index (LOWSI) in collaboration with salmon and lumpfish farmers. This followed a step by step process, where initially biometric and Welfare data as recorded from fish hatcheries and salmon farms. Stakeholders were consulted and an initial prototype of the scoring index was presented in a workshop and optimized following farmers recommendations.

Once the LOWSI was optimised we worked with fish farmers, software developers, and designers to créate the tool.

2. PILOT DESIGN

Aims: To develop tailored tools to monitor and improve the welfare of lumpfish

Objectives:

To develop four innovative and complementary solutions, spanning TRL7 to TRL9, to help farmers monitor the welfare of lumpfish and take remedial actions:

1. A diagnostic welfare scoring chart that can be used by fish farmers on site
2. An online BMI calculator to detect underweight lumpfish
3. An online Rapid Welfare Assessment tool for lumpfish
4. An e-training platform

Methodology:

CSAR researchers developed and validated a rapid Lumpfish Operational Welfare Score Index (LOWSI) in collaboration with salmon and lumpfish farmers. This followed a setep by step process, where initially biometric and Welfare data as recorded from fish hatcheries and salmon farms. An initial prototype of the scoring index was presented in a workshop and optimized following farmers recommendations.

Once the LOWSI was optimised we worked with fish farmers, software developers, and designers to créate the tool,

- **Scientific papers**
  - Garcia de Leaniz, C. et al., 2021. Addressing the welfare needs of farmed lumpfish: knowledge gaps, challenges and solutions. Reviews in Aquaculture (in press). DOI: 10.1111/raq.12589 https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12589
  - Gutierrez-Rabadan, C., Spreadbury C., Consuegra, S. & Garcia de Leaniz, C. 2021. Development and validation of an Operational Welfare Score Index for farmed lumpfish Cyclopterus lumpus L. Aquaculture 531, 2021, 735777, ISSN 0044-8486, https://doi.org/10.1016/j.aquaculture.2020.735777

3. PILOT IMPLEMENTATION

CSAR researchers developed and validated a rapid Lumpfish Operational Welfare Score Index (LOWSI) in collaboration with salmon and lumpfish farmers. Our aim is to make this index accessible to farms by developing

The Lumpfish Welfare Watcher a web-based application that will calculate the BMI (relative weight) of lumpfish, determine the proportion of fish that are emaciated, underweight, and normal, along with recommendations for action. The application also calculates the Lumpfish Operational Welfare Score Index (LOWSI) based on four visual indicators (skin damage, eye condition, caudal fin damage and suction disc deformities) and the BMI.

It also calculates the probability of escape from salmon net pens with nets of various mesh sizes. The Lumpfish Welfare Watcher application package includes a user manual, a lumpfish Welfare chart and a e-training course that was disseminated via YouTube video, Workshop sessions, magazines and expertise journals.

4. PILOT ASSESSMENT

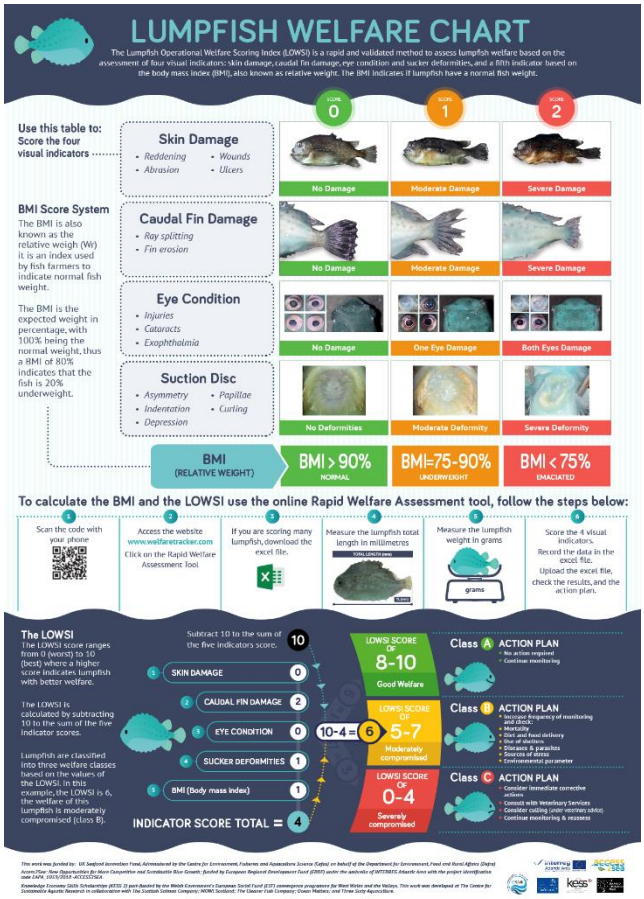
- Number of users
- Feedback from users
- Endorsement from RSPCA

5. PILOT TRANSFERABILITY

BMI calculator – available to access online and to download (https://bsciweb.swan.ac.uk/lumpfish/)

User Manual: available online to download

The welfare chart is available to download on the Lumpfish Welfare watcher website



The software tools and the chart were distributed as follows:

- The chart was sent to 22 institutions during an interview survey conducted by a consultant company (see objective 2) to provide feedback and quality assurance
- The chart was printed and distributed to 75 farmers at the Lochaber Chamber of Commerce Ideas week – Aquaculture Day, 17 November 2021
- The chart was printed and distributed to 50 stakeholders during the Aquaculture UK evento 5th May 2022
- The software was explained and tested by the farmers in the above events

On the 25th of May CSAR hosted a webinar entitled: Application of sensors in precision aquaculture: presentation available to download. Dr Sara Barrento gave a talk where she introduced the lumpfish welfare watcher.

- A total of 157 participants from 33 countries attended the webinar (#aquasensors).
- The webinar is available to watch on YouTube (413 views on 2 February, 2022)
- The webinar quality assessment report is also available

6. RESULT DESCRIPTION

We co-authored a scientific paper with fish farmers, welfare standard institution (RSPCA-assured) and researchers. We involved all key players in development process and as a consequence all are now fully aware of welfare needs.

We developed a lumpfish welfare scoring index and translated it into an easy to use tool that is now used by the industry. As a consequence farmers are more aware of lumpfish welfare, we expect the productivity to increase, and the delousing may be more efficient, due to improvements in welfare.

We are in the process of implementing the E-learning and the tool in the MOWI Academy, MOWI is one of the biggest multinational salmon farm companies, based in Norwy, Scotland and Chile. RSPCA is also in the process of endorsing the tool.

Feedback from dissemination events :

Lochaber Chamber of Commerce Ideas week – Aquaculture Day, 17 November 2021

Hi Sara,

A big thank you from all of the team at SAIC for taking part in yesterday's aquaculture day as part of Lochaber Ideas Week. Your presentation content and your presence helped to make the event a huge success, with really useful, thought-provoking information and the excellent conversations that took place as a result. We loved your presentation style and the way you engaged with the attendees

This was our first in-person event since February 2020 and we were so delighted to have everyone back in the room together again and sharing ideas!

We have had excellent feedback from the attendees so far and a lot of requests to share the presentations. Would you be happy for me to share a PDF copy of your slides with the registered attendees?

Thanks again and if you would like to provide any feedback, please feel free to reply to my email or give me a call.

Best wishes,

:

Hi Sara

It was good to see you at the meeting in Fort William last week, albeit for a short time.

Just to let you know, i think your presentation went down really well with the audience, its an important message you are putting across, its so important that it gets out to the widest audience as possible, the Lumpfish welfare tool will make a big difference on the farms. As you know there are still many concerns regarding the welfare of the Lumpfish once they are deployed onto sea sites, it's one of the areas of concern we are looking at so your on line tool can only help improve the welfare of the Lumpfish.

"I am working with an institution in Atlantic Canada who would be very interested in learning from you."

Feedback from Aquaculture UK workshop:

- "Very easy to use app"
- "Great seminar at Aquaculture UK, engaging & helpful"
- "Great presentation about a very useful tool developed to improve welfare of cleaner fish. Wondering if a similar tool would also work for the farmed fish such as Salmon, Trout etc"

7. INDICATORS

- Number of case studies and pilot actions implemented:1

- Number of users
- Feedback questionnaires
- Endorsement by RSPCA

7.1 SME's involved

Country	Organisation	Type
Canada	Department of Ocean Sciences, Memorial University of Newfoundland	Research institution
	Newfoundland Aquaculture Industry Association	Industry Association
	Aquaculture Association of Nova Scotia	Industry Association
	Mowi Canada East	Salmon Farmer
	Greig Canada	Salmon Farmer
	Cooke Aquaculture	Salmon Farmer
USA	Global Aquaculture Alliance	Standards Body
	Aquaculture Research Center, Maine, USDA	Gov. Research Center
	University New Hampshire	Ocean Research Center
UK	Organic Sea Harvest Ltd	Salmon Farmer/ Cleaner fish supervisor
	Mowi Scotland	Salmon Farmer/Fish health
	Scottish Sea Farms	Salmon Farmer/ Head of Fish Health
	SAIC	Aquaculture Innovation Centre
	Greig	Cleaner Fish Supervisor

	Scottish Salmon Company	Cleaner Fish Supervisor
	Loch Duart Salmon	Cleaner fish Manager
	Wester Ross Salmon	Fish Health & Business Development Manager
	RSPCA Standard	Aquaculture manager
England	Devon Coast Aquaculture Forum	Forum for Aquaculture Innovation
Ireland	Mowi Ireland	Salmon Farmer
	TBT Salmon Farm	Salmon Farmer
	BIM	Development Agency
	Marine Institute, Aquaculture Research	State Research Agency and Fish Health Regulator
	Marine Institute, Blue Economy Manager	State Agency for Science based Policy Formation
	Bantry Bay Research Station	Hatchery/Research
	Fish Vet Group	Fish health and welfare vet. Service provider
Netherlands	Aquaculture Stewardship Council	Standards Body

Audio-visual material

Videos:

1. **Lumpfish Welfare watcher explained by Dr Sara Barrento**
   https://www.youtube.com/watch?v=9vuouYdk0f4
2. **How to score the welfare of lumpfish**
   https://rise.articulate.com/share/O9TJsPdUJgmgvrW9LCOlTSnSJ_PVIpDk#/lessons/crXNUSKWfADTN9PdjnSwjbPPP0JhQyIT

E-learning:
https://rise.articulate.com/share/O9TJsPdUJgmgvrW9LCOlTSnSJ_PVIpDk#/

App: https://bsciweb.swan.ac.uk/lumpfish/

Articles in dedicated magazines:

Three press releases were published in The Fish Site

1. **October 2020 Date set for aquaculture welfare event**
   https://thefishsite.com/articles/date-set-for-aquaculture-welfare-event

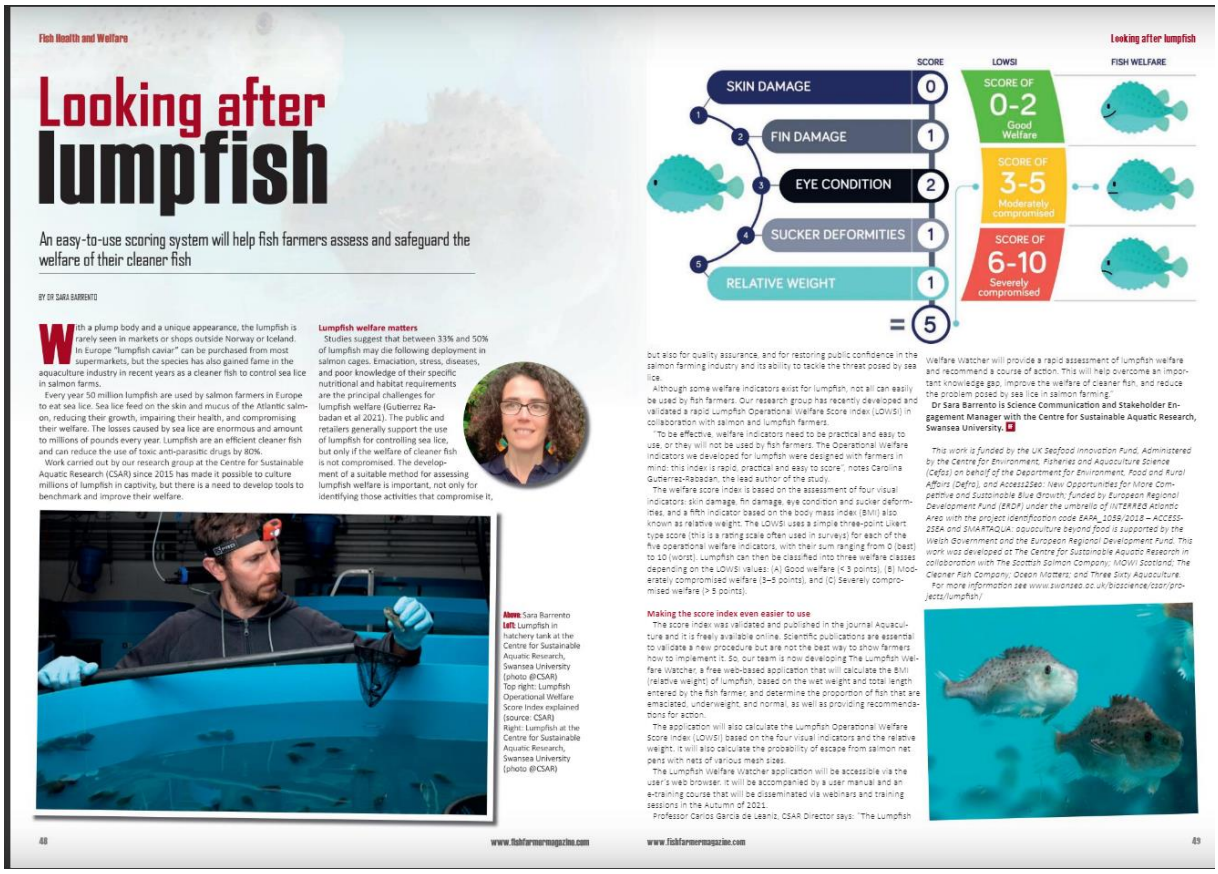
2. **December 2020 Fish welfare insights now available**
   (https://thefishsite.com/articles/fish-welfare-insights-now-available-online)

3. **May 2021 Exploring Sensors in precision aquaculture**
   https://thefishsite.com/articles/exploring-sensors-in-precision-aquaculture

Three press releases were published in the Fish Farmer Magazine

1. **April 2021 Looking after lumpfish page 48-49**

https://issuu.com/fishfarmermagazine/docs/fish_farmer_april_2021_830aa1a3f5734b



Fish Health and Welfare

Looking after lumpfish

An easy-to-use scoring system will help fish farmers assess and safeguard the welfare of their cleaner fish

BY DR SARA BARRENTO

With a plump body and a unique appearance, the lumpfish is rarely seen in markets or shops outside Norway or Iceland. In Europe "lumpfish caviar" can be purchased from most supermarkets, but the species has also gained fame in the aquaculture industry in recent years as a cleaner fish to control sea lice in salmon farms.

Every year 50 million lumpfish are used by salmon farmers in Europe to eat sea lice. Sea lice feed on the skin and mucus of the Atlantic salmon, reducing their growth, impairing their health, and compromising their welfare. The losses caused by sea lice are enormous and amount to millions of pounds every year. Lumpfish are an efficient cleaner fish and can reduce the use of toxic anti-parasitic drugs by 80%.

Work carried out by our research group at the Centre for Sustainable Aquatic Research (CSAR) since 2015 has made it possible to culture millions of lumpfish in captivity, but there is a need to develop tools to benchmark and improve their welfare.

Lumpfish welfare matters

Studies suggest that between 33% and 50% of lumpfish may die following deployment in salmon cages. Emaciation, stress, diseases, and poor knowledge of their specific nutritional and habitat requirements are the principal challenges for lumpfish welfare (Gutierrez Rabadan et al 2021). The public and retailers generally support the use of lumpfish for controlling sea lice, but only if the welfare of cleaner fish is not compromised. The development of a suitable method for assessing lumpfish welfare is important, not only for identifying those activities that compromise it, but also for quality assurance, and for restoring public confidence in the salmon farming industry and its ability to tackle the threat posed by sea lice.

Above: Sara Barrento
Left: Lumpfish in hatchery tank at the Centre for Sustainable Aquatic Research, Swansea University (photo @CSAR)
Top right: Lumpfish Operational Welfare Score Index explained (source: CSAR)
Right: Lumpfish at the Centre for Sustainable Aquatic Research, Swansea University (photo @CSAR)

Although some welfare indicators exist for lumpfish, not all can easily be used by fish farmers. Our research group has recently developed and validated a rapid Lumpfish Operational Welfare Score Index (LOWSI) in collaboration with salmon and lumpfish farmers.

"To be effective, welfare indicators need to be practical and easy to use, or they will not be used by fish farmers. The Operational Welfare Indicators we developed for lumpfish were designed with farmers in mind: this index is rapid, practical and easy to score", notes Carolina Gutierrez-Rabadan, the lead author of the study.

The welfare score index is based on the assessment of four visual indicators: skin damage, fin damage, eye condition and sucker deformities, and a fifth indicator based on the body mass index (BMI) also known as relative weight. The LOWSI uses a simple three-point Likert type score (this is a rating scale often used in surveys) for each of the five operational welfare indicators, with their sum ranging from 0 (best) to 10 (worst). Lumpfish can then be classified into three welfare classes depending on the LOWSI values: (A) Good welfare (< 3 points), (B) Moderately compromised welfare (3–5 points), and (C) Severely compromised welfare (> 5 points).

Making the score index even easier to use

The score index was validated and published in the journal Aquaculture and it is freely available online. Scientific publications are essential to validate a new procedure but are not the best way to show farmers how to implement it. So, our team is now developing The Lumpfish Welfare Watcher, a free web-based application that will calculate the BMI (relative weight) of lumpfish, based on the wet weight and total length entered by the fish farmer, and determine the proportion of fish that are emaciated, underweight, and normal, as well as providing recommendations for action.

The application will also calculate the Lumpfish Operational Welfare Score Index (LOWSI) based on the four visual indicators and the relative weight. It will also calculate the probability of escape from salmon net pens with nets of various mesh sizes.

The Lumpfish Welfare Watcher application will be accessible via the user's web browser. It will be accompanied by a user manual and an e-training course that will be disseminated via webinars and training sessions in the Autumn of 2021.

Professor Carlos Garcia de Leaniz, CSAR Director says: "The Lumpfish Welfare Watcher will provide a rapid assessment of lumpfish welfare and recommend a course of action. This will help overcome an important knowledge gap, improve the welfare of cleaner fish, and reduce the problem posed by sea lice in salmon farming."

Dr Sara Barrento is Science Communication and Stakeholder Engagement Manager with the Centre for Sustainable Aquatic Research, Swansea University.

This work is funded by the UK Seafood Innovation Fund. Administered by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) on behalf of the Department for Environment, Food and Rural Affairs (Defra), and Access2Sea: New Opportunities for More Competitive and Sustainable Blue Growth, funded by European Regional Development Fund (ERDF) under the umbrella of INTERREG Atlantic Area with the project identification code EAPA_1059/2018 – ACCESS-2SEA and SMARTAQUA: aquaculture beyond food is supported by the Welsh Government and the European Regional Development Fund. This work was developed at The Centre for Sustainable Aquatic Research in collaboration with The Scottish Salmon Company; MOWI Scotland; The Cleaner Fish Company; Ocean Matters; and Three Sixty Aquaculture.

For more information see www.swansea.ac.uk/biosciences/csar/projects/lumpfish/

2. June 2021 – Talking sensors page 47

https://issuu.com/fishfarmermagazine/docs/fish_farmer_jun_2021

CSAR - Centre for Sustainable Aquatic Research

Talking sensors

A total of 157 participants from 33 countries attended the webinar on the Application of Sensors in Precision Aquaculture (#aquasensors).

Hosted by Swansea University's Centre for Sustainable Aquatic Research (CSAR) in collaboration with the Waterford Institute of Technology on 25 of May 2021, the webinar is now available on YouTube and the talks can be downloaded from the website.

Dr Sara Barrento, marine biologist and science communicator at CSAR, introduced the webinar topic and noted the motivation behind the need for precision aquaculture for real-time sensor technology to facilitate sustainable management of aquaculture facilities as they increase in size and become more advanced, locate further offshore and aim towards restorative aquaculture.

Dr Barrento also introduced the Access2Sea project pilot case study on lumpfish welfare. The team at CSAR is developing the Lumpfish Welfare Watcher a web-based application that will calculate the Lumpfish Operational Welfare Score Index (LOWSI) based on four visual indicators (skin damage, eye condition, caudal fin damage and suction disk deformities), and the relative weight. The application will also have a Body Mass Index (BMI) calculator, funded by the Seafood Innovation Fund, the calculator allows to determine the proportion of lumpfish that are emaciated, underweight, and normal, along with recommendations for action.

Professor Carlos Garcia de Leaniz, director of CSAR at Swansea University, introduced the STREAM (Sensor Technologies for Remote Environmental Aquatic Monitoring) project. The project is monitoring Coastal and Estuarine environments around both Ireland and Wales using cost effective sensors to support the coastal industry (including aquaculture), environmental and climate science.

Dr Sofia Teiveira of the Tyndall Institute in Ireland presented on smart sensors for wellness and health in aquaculture. These sensors are non-invasive and provide rapid tests to monitor health by measuring indicators, such as cortisol, that have wide applications in the assessment of the immune competence, stress, growth, and behaviour.

Professor David Gethin, of the Welsh Centre for Printing and Coating (WCPC) at Swansea University, gave a brief overview of commercial sensors and highlighted the benefits of printable sensors; they are less expensive and can measure a range of parameters in an integrated system. However, printable sensors need to be calibrated against laboratory and commercial devices, and their durability still needs to be tried and tested. Professor Gethin also provided an overview of the methods used to print the sensors being developed for the STREAM project.

Brian O'Loan, of Bord Iascaigh Mhara gave a very informative presentation on the shellfish aquaculture industry in the SE of Ireland. He began by explaining the value of shellfish aquaculture in the region and the impacts that the Covid-19 pandemic has had on the industry. Mr O'Loan then discussed the commercial sensors he had used in the past outlining the good and bad points of each. Mr O'Loan presented data that he had recorded in the area during previous sampling programmes and projects. Mr O'Loan concluded by reiterating the pressures faced by the Aquaculture industry and the need for more affordable, spatially, and temporally sophisticated real-time monitoring with notifications if a parameter goes outside a pre-defined level.

Paul Shanahan, of the National Maritime College of Ireland (NMCI), highlighted the advantages that coastal radar systems provide, such as accurate local weather information which can be disseminated to social media and coastal stakeholders who can make choices on whether it is safe/ suitable to carry out an activity/ operation on a given day. Mr Shanahan explained the type of radar in use, its characteristics, locations and showed the data it generates talking the audience through the various characteristics of the radar display. The STREAM project is hoping to deploy one of these radars in Swansea, Wales in the near future.

Paul Howes (top left), Manager of the Centre for Sustainable Aquatic Research, alongside Dr Pete Jones (middle) and Dr Josh Jones (bottom), researchers working on the STREAM projects at Swansea University, did a talk on the research taking place in CSAR using sensors. Mr Howes focused on the unique facilities and projects taking place in CSAR, using a variety of species from microalgae to fish, and topics such as aquaponics and aqua biotech. Dr Pete Jones focused on experimental lab work using sensors for determining preference and avoidance thresholds for marine organisms. Dr Josh Jones focused on the mapping opportunities and challenges for aquaculture and fisheries, using relevant data from sensors.

Gyopár Elekes, of faptic.xyz, focused on the use of machine vision technology that can access lumpfish clinging behaviour. The technology uses underwater cameras to record stereoscopic images, the AI and deep learning algorithms allow collecting key data which will then inform on the number of fish, define thresholds for fish density and, in the case of lumpfish, access the proportion of fish clinging and swimming.

Christian Berger, of PEBL – Plant Ecology Beyond Land, focused on the importance of monitoring low trophic sea farms: the data can be used to inform on the ideal location of new aquaculture sites, create optimized harvest schedules, provide early warning and troubleshooting and validate sustainable objectives (carbon, nitrogen, biodiversity). He presented the SeaLens: a low-cost sea farm monitoring tool and a case study on a proposed seaweed and shellfish farm in Skye.

The webinar on the Application of Sensors in Precision Aquaculture had the support from the European Project Access2Sea funded by the Interreg Atlantic Area Programme through the European Regional Development Fund and STREAM: Sensor Technologies for Remote Environmental Aquatic Monitoring funded by the European Regional Development Fund through the Ireland Wales Cooperation programme.

3. April 2022 Improving Lumpfish Welfare page 24 and page 78
https://issuu.com/fishfarmermagazine/docs/fish_farmer_april_22

CSAR – client content

Improving lumpfish welfare

Researchers at the University of Swansea have developed a new tool to help in the care of lumpfish

Swansea University will be delivering an exciting workshop at the Aquaculture UK trade show, entitled "Tools for improving the welfare of lumpfish". The workshop will take place on 5 May 2022 from 12:00 to 13:00 and is free to all attendees.

The workshop will consist of two main topics followed by a discussion panel:

1) facilitated hands-on test session of the Lumpfish Welfare Watcher – a web-based and desktop application designed to help fish farmers assess and improve the welfare of Lumpfish; and
2) using AI to improve lumpfish welfare.

During the workshop, attendees will get a free lumpfish welfare chart and learn how to use it in combination with the following lumpfish welfare tools: the lumpfish BMI calculator for the detection of underweight fish and the Rapid Welfare Assessment Tool to calculate the overall welfare of lumpfish.

On 4 May, CSAR will be at SAIC's stall from 15:00 to 15:30, showcasing its cleaner fish research and how CSAR is training the next generation of aquaculture professionals.

"We encourage everyone interested in fish welfare – farmers, researchers, students, vets, and welfare interest groups to attend this exciting workshop", said Dr Sara Barrento, Swansea University, speaker and organiser of the workshop.

This is the second joint event in a series organised and supported by the projects Access2Sea, funded by the Interreg Atlantic Area Programme through the European Regional Development Fund and the Seafood

Innovation Fund (SIF). It is led by the Centre for Sustainable Aquatic Research (CSAR), Swansea University

The first event took place during Lochaber Ideas Week – Aquaculture Day in Fort William, Scotland on 17 November 2021.

For more information:

Lochaber Ideas Week link www.sustainableaquaculture.com/news-events/lochaber-ideas-week-aquaculture-day/

SIF: bsciweb.swan.ac.uk/lumpfish/docs/LUMPFISH_WELFARE_WATCHER_WEB_INTERFACE_GUIDE.pdf

Acces2Sea

access2sea.eu/event/application-of-sensors-in-precision-aquaculture/

To learn more and keep up to date on coming events follow us on Twitter @CSAR_ACE twitter.com/csar_ace

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  www.asemaonline.com

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