Aquaculture at the Centre for Sustainable Aquatic Research using sensors

Paul Howes
Dr Pete Jones
Dr Josh Jones
Swansea University
Centre for Sustainable Aquatic Research

Application of Sensors in Precision Aquaculture

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Prifysgol Abertawe
Swansea University

CSAR
Centre for Sustainable Aquatic Research
Canolfan Ymchwil Dyfrol Cynaliadwy

Who are we?

Created with sustainability as a core principle in order to:

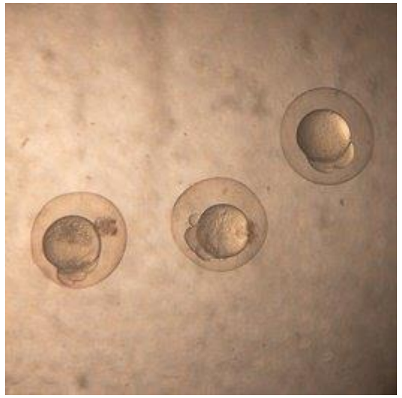
- Deliver unique training and research in aquatic science to enhance the student experience
- Deliver impactful and far-reaching research
- Provide meaningful support to industry, particularly in the areas of sustainable aquaculture, algal biotechnology and sector development

What do we do?

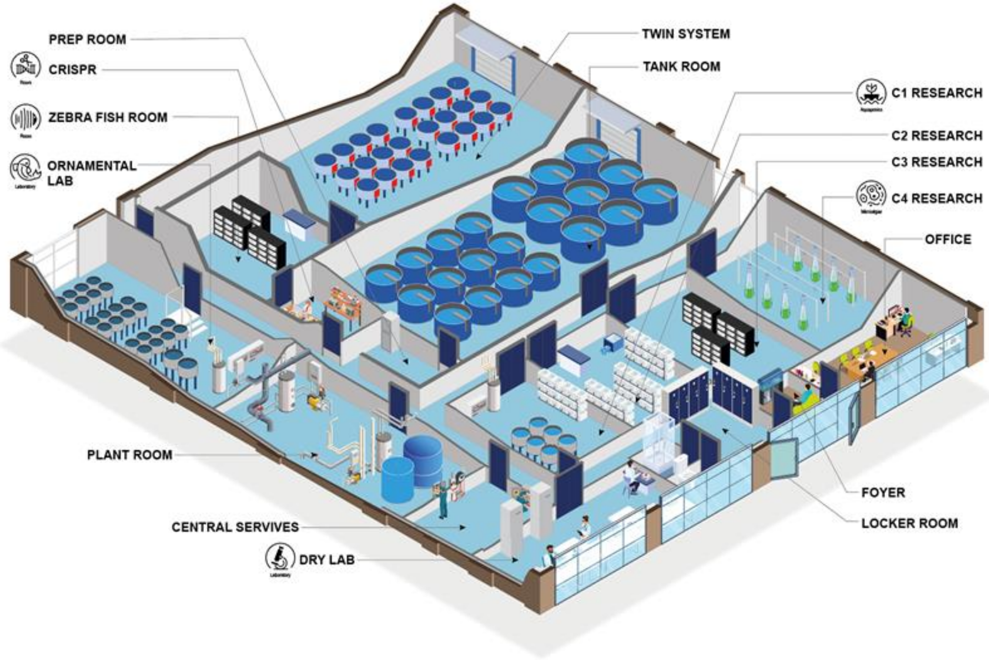
Areas of Expertise within CSAR:

- Welfare in aquaculture and aquatic research
- Larval culture
- Algal biotechnology
- Epigenetics
- Environmental impacts of aquaculture
- Ecosystem modelling
- ***Aquaculture hatchery technologies***






Facilities at CSAR



15 dedicated aquatic research laboratories including:

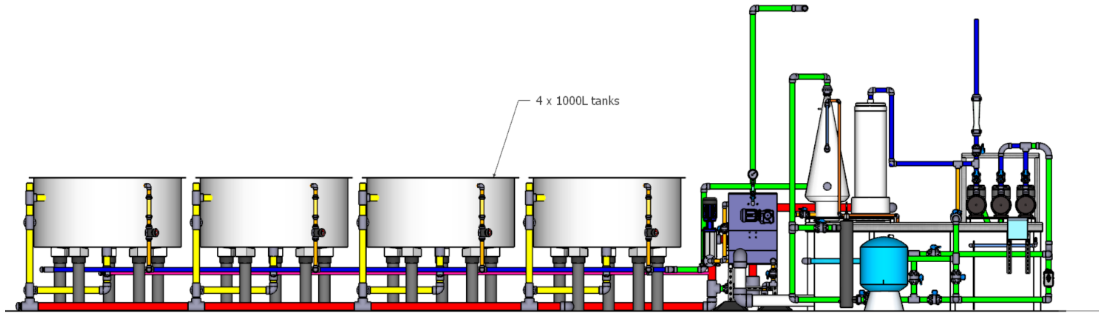
13 RAS systems ranging from 2m cubed to 60 meters cubed volume

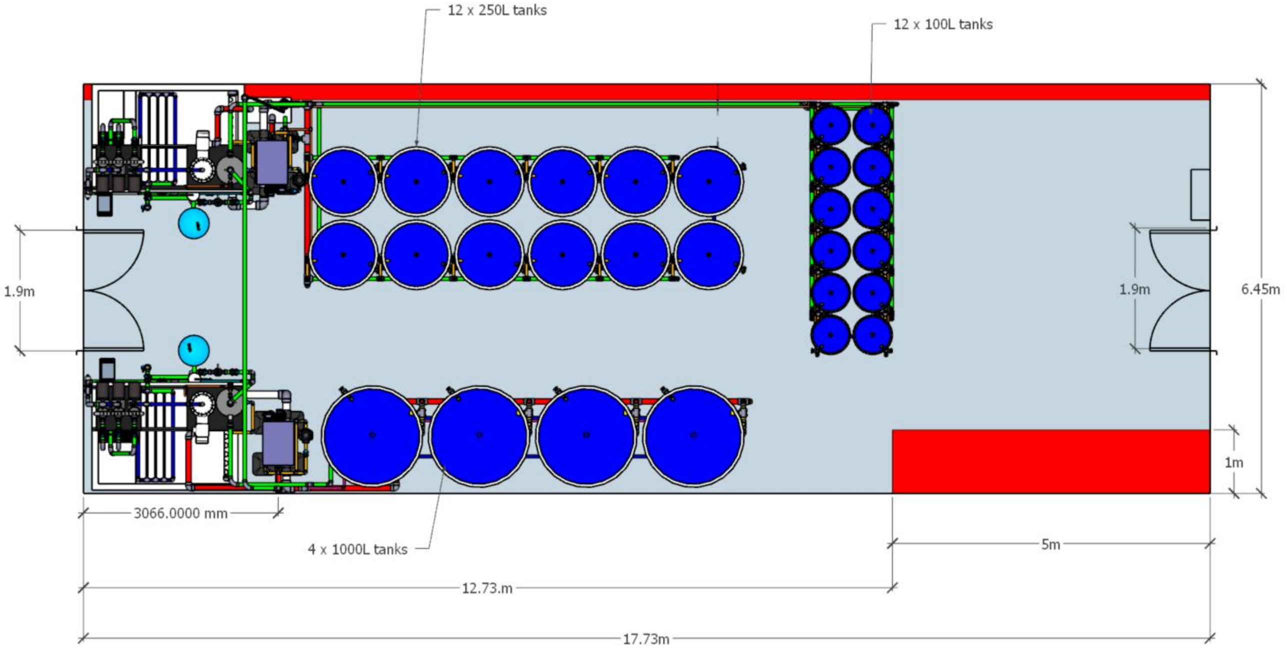
12 model RAS racks for laboratory fish

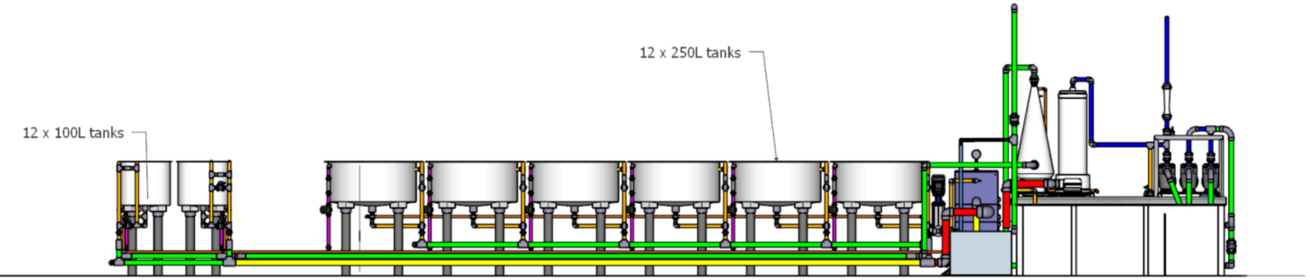
Temperature controlled from 8 - 30 degrees Celsius

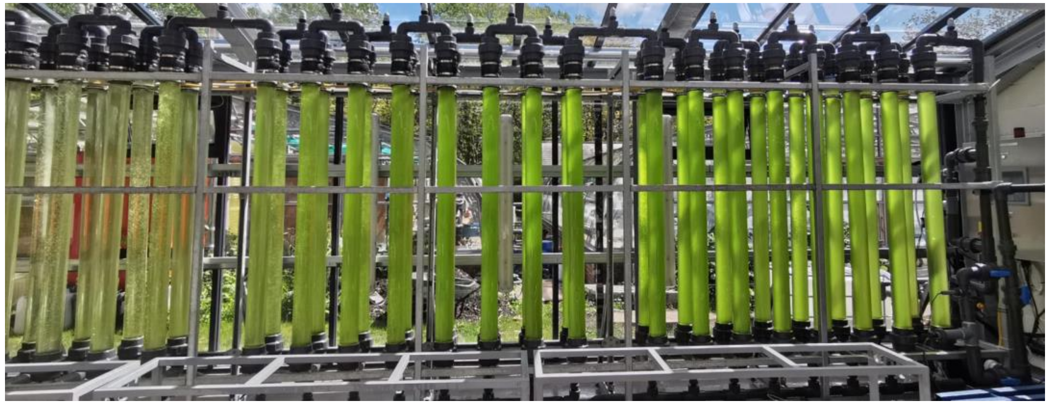
Wales Aquaculture Centre of Excellence – Wales ACE

Multi-Trophic Aquaculture at CSAR







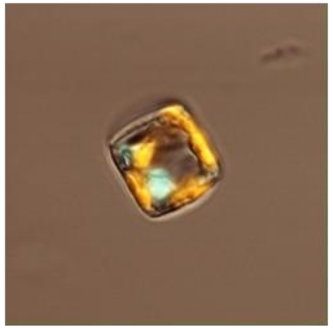


PBR from ALG-AD and EnhanceMicroAlgae INTERREG projects

Comprehensive suite of facilities for Algal Biotechnology

Interreg
EUROPEAN UNION
North-West Europe
ALG-AD
European Regional Development Fund

- 25+ master cultures
- 20 x 100L batch culture in a controlled environment lab
- 6 Biofences from 400l to 5000l



Paul Howes, Dr Peter Jones and Dr Josh Jones

Excellence in welfare = robust research data

NACWO

Monitoring fish
Staff training in humane killing listed in ASPA Schedule 1
Replacement, Reduction and Refinement (3 R's)

Fish Vet

Weekly visits from Vet (fish specialist)
Training staff on injection techniques, signs of ill health, histology and dissection
Collaborations with staff in the field of disease
Lumpfish Endoscopy

Animal welfare technician

Responsible for ensuring optimal rearing conditions for animals involved in trials and dissertations
Coaching researchers on animal husbandry
Setting up systems to provide high welfare standards

Sensor technology in CSAR for monitoring and controlling systems.

As with many RAS facilities, CSAR makes use of probes to monitor and adjust the following parameters:

- Air temp, Water temp
- Salinity
- pH
- Oxygen levels
- CO2 levels
- Ozone
- Flow rates
- Tank depth

In addition, all probes are linked to a central alarm system which includes hardware failure backup

How can the current sensor tech in the sector be enhanced?

Advancing sensor use for aquatic production

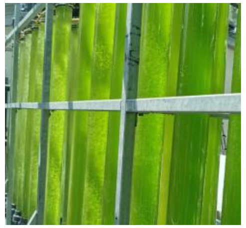
Incorporating sensors in the circular economy

Sensor tech is to be incorporated at each trophic stage to optimise and monitor nutrient proportions.

Sensor tech

Feed formulation

Sensor tech

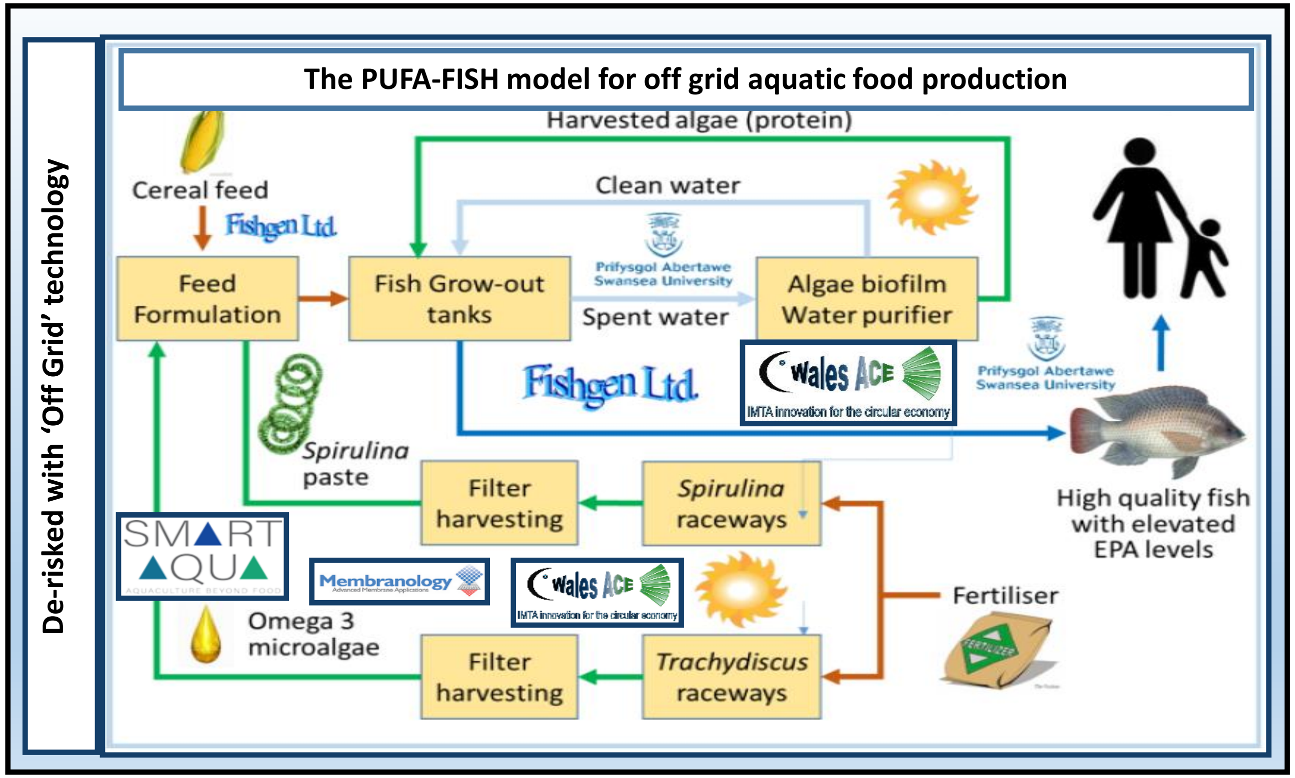


Sensor tech

Down Stream processing

Sensor tech

Incorporating sensors in LIC's/Marginal environments



Incorporating sensors in the Biophilic sector

Picton Yard Biophillic Development

- 22,000sqft Grade A Commercial Office Space
- 44 residential units
- New public event space
- Aquaponics Centre and vertical garden
- Public viewing aquarium
- The living building
- Energy capture materials

Funding **4.6 million** from Innovative Housing Programme **10.4 million** in private investment

Determining preference and avoidance thresholds for marine organisms

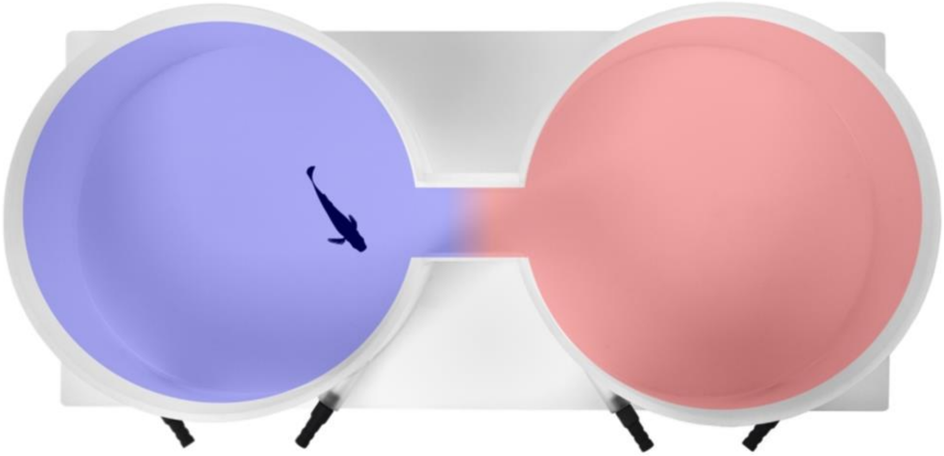
Shuttle box experiments

Allow choice experiments for fish and crustaceans

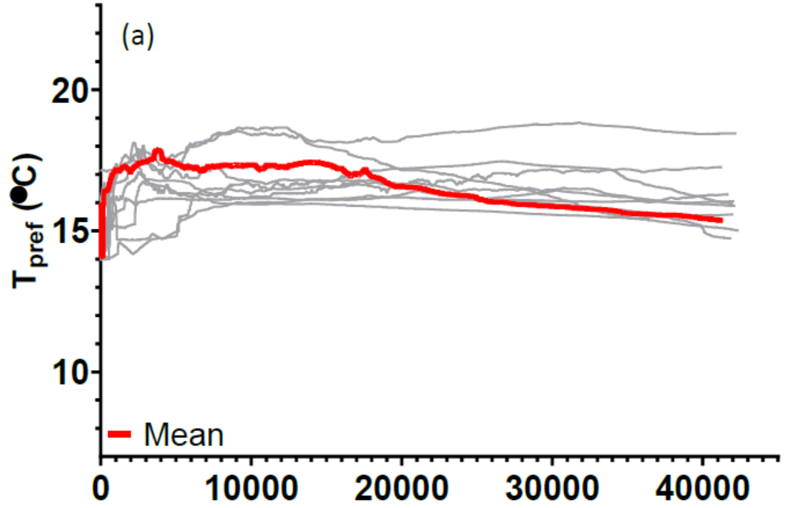
Can manipulate water quality parameters on each side independently

Organisms can detect differences at interface and can shuttle back and forth to control ambient conditions

Monitor movements with overhead camera

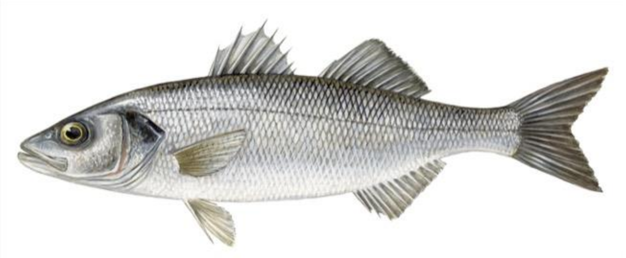


Source: loligosystems.com, 2021



Source: Harman et al., 2020

Determining preference and avoidance thresholds for marine organisms



Shuttle box outputs

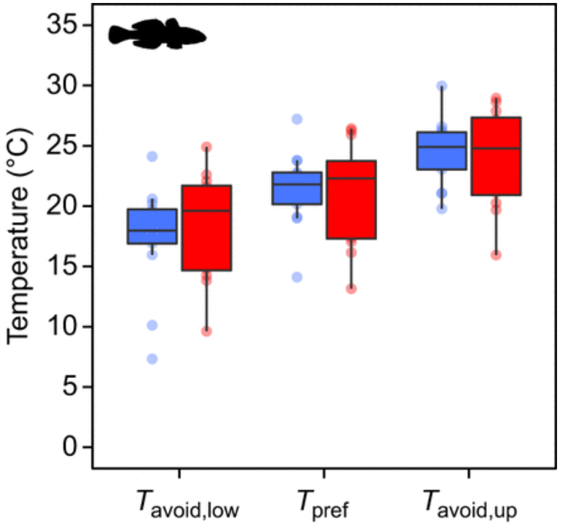
Sea bass (*Dicentrarchus labrax*)

Temperature, DO, pH, pCO_2, salinity

Preference and avoidance thresholds for a range of species

Can be used to identify areas with suitable water parameters for aquaculture

Predict how habitat suitability and species distributions are likely to change with predicted climate change



Temperature preference and avoidance temperature of round goby (Source: Christensen et al., 2021)

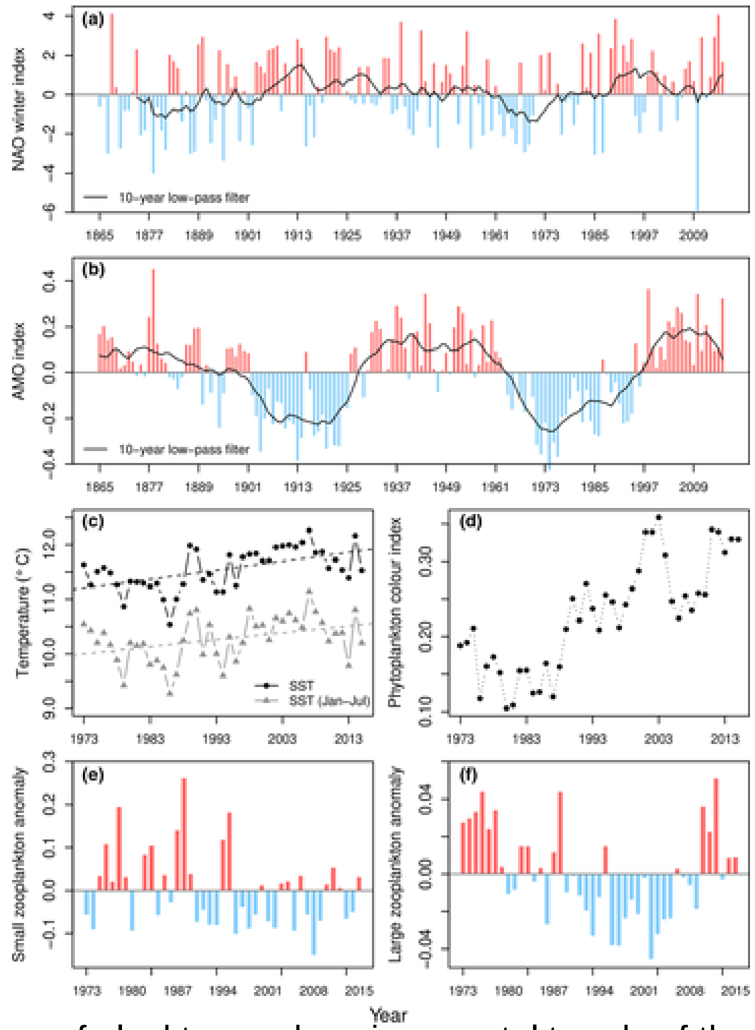
Mapping opportunities and challenges for aquaculture and fisheries

Historic suitability mapping

Dynamic Energy Budget theory (koijman, 2010)

Model historic aquaculture and fisheries suitability using:

Bathymetry, chlorophyll-a, current speed, temperature, pH



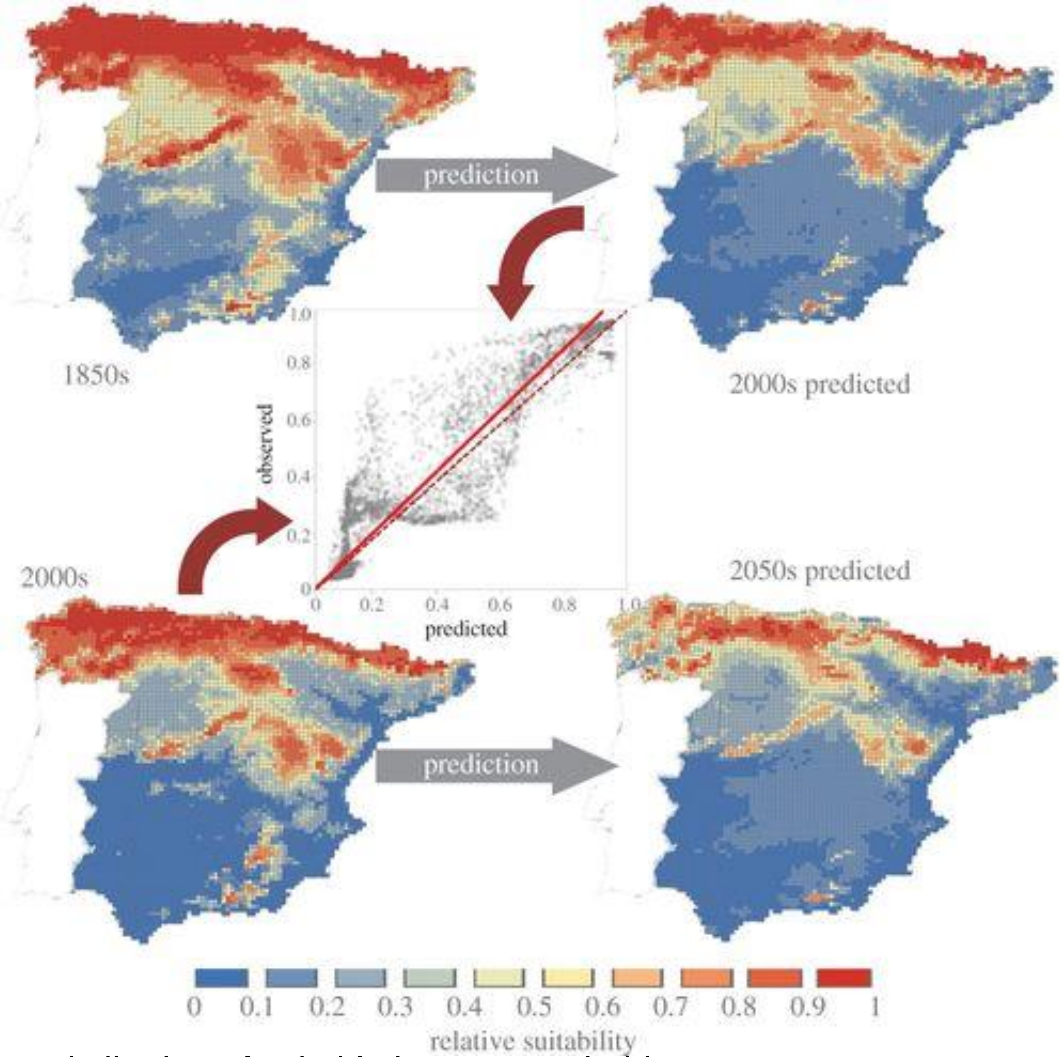
100 years of plankton and environmental trends of the Irish Sea (Bentley et al., 2020)

Mapping opportunities and challenges for aquaculture and fisheries

Current suitability

Validate historic distribution models using contemporary species distributions and environmental data

Cross reference these with mesocosm experiments

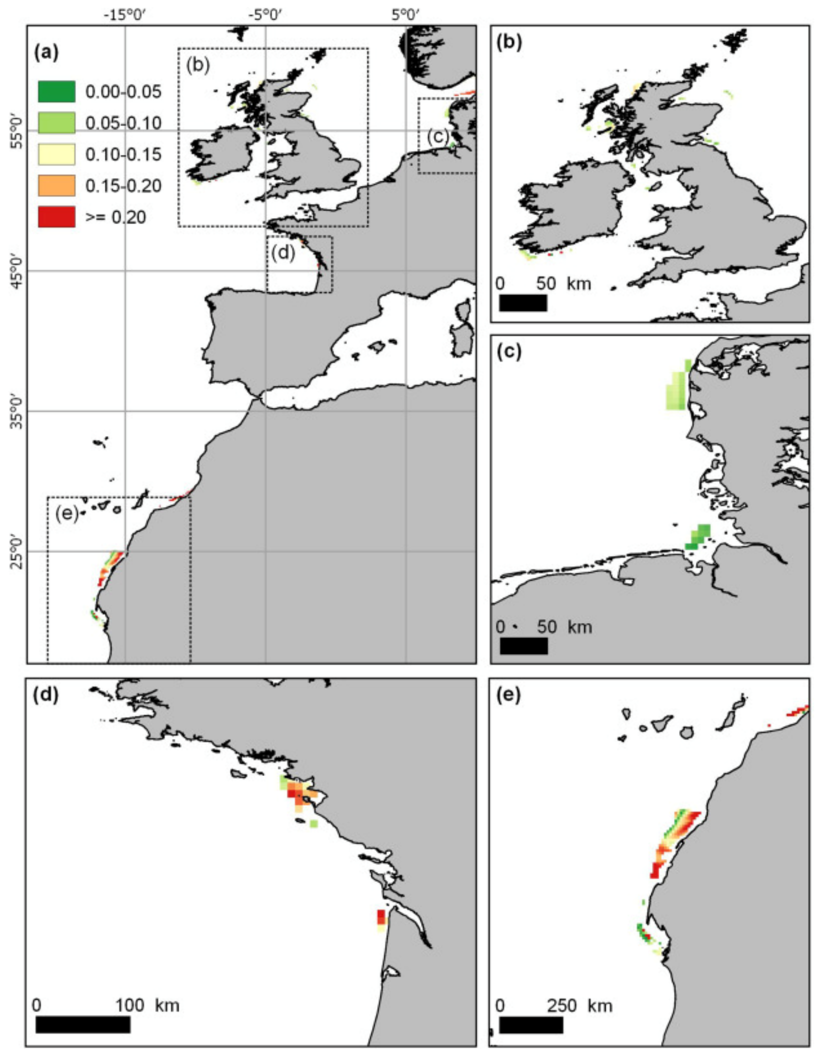


Distibution of suitable brown trout habitat (Clavero et al., 2017)

Mapping opportunities and challenges for aquaculture and fisheries

Suitability projections

Estimate impacts of climate change scenarios to assess future opportunities and challenges



Pacific oyster cultivation suitability under climate change scenarios (Palmer et al., 2021)