



Dr David Willer

Henslow Research Fellow, Murray Edwards College
E: dw460@cam.ac.uk
W: <https://www.zoo.cam.ac.uk/directory/david-willer>



Our Fish & Seafood Innovation approach targets five key areas

Fish & Seafood Conundrum

- Nutritious small fish and fish by-products are used for feed and oil
- Bivalves are nutrient dense and sustainable yet we eat little of them
- Overall consumption of fish and seafood is lower than good for us
- Yet wild fishing is at capacity, and aquaculture expanding unsustainably

Sector Policy Breakthroughs

e.g. in salmon farming to deliver more micronutrients to people`



Fish & Seafood Product Innovation

e.g. stakeholder engagement to develop mass-market foods

Novel Species Aquaculture Innovation

e.g. shell-less clams to turn wood into protein

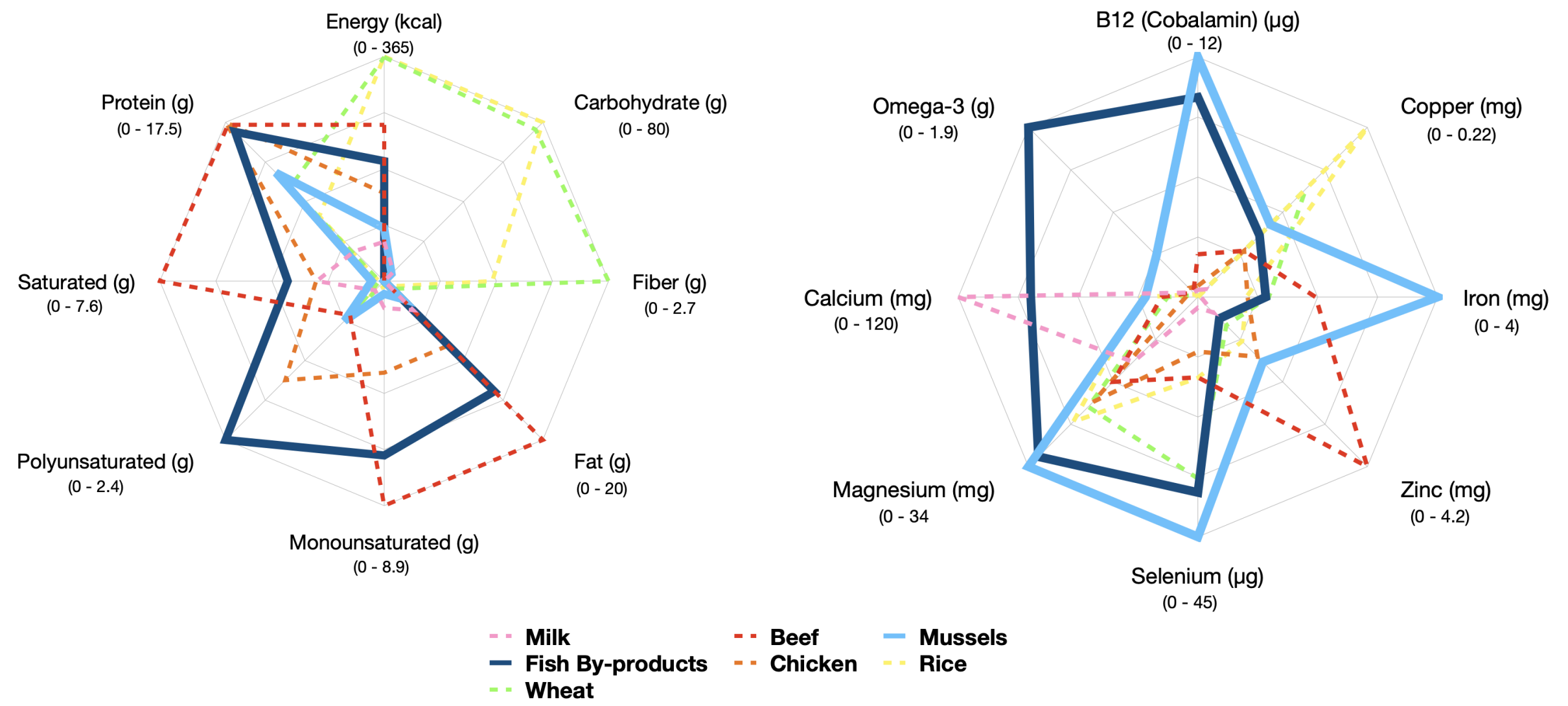
Making the Sustainable Economically Attractive

e.g. identifying how to drive direct consumption of bivalves and by-products

Fish & Seafood Demand Stimulation

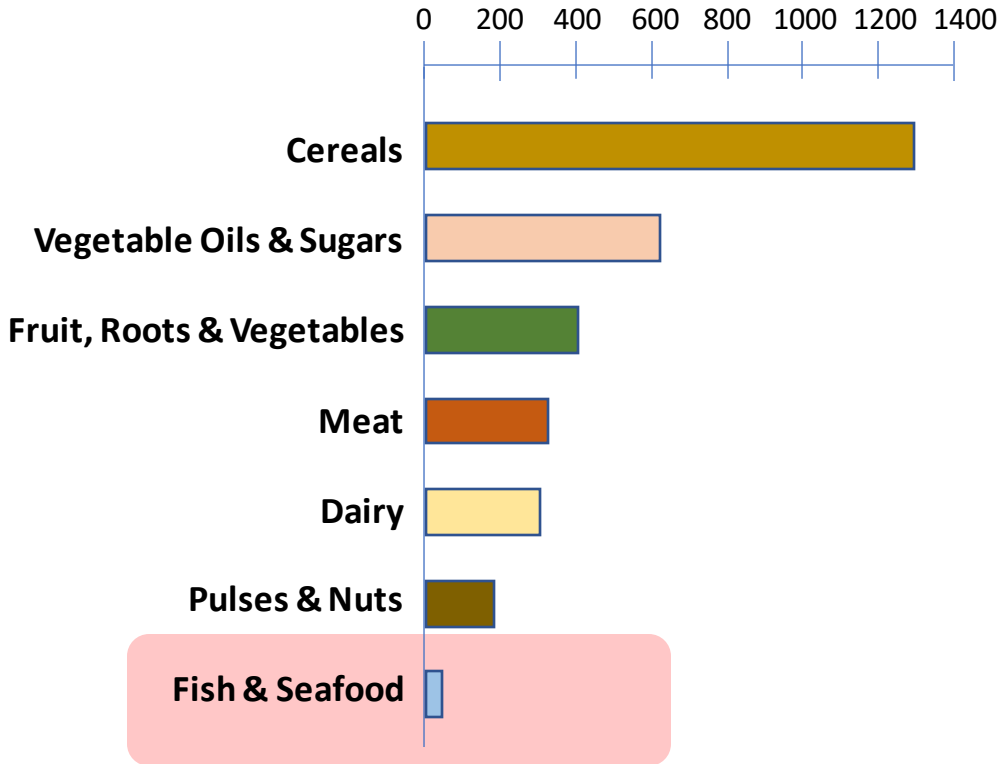
e.g. processing and convenience to increase consumption

Fish by-products and bivalves are nutrient dense



Consumption of fish & seafood is lower than good for us

Global calories per capita per day



We eat less fish than recommended for nutritional benefit

UK guidelines: Consume >280g of fish per week, actual in 2022 162g

Bivalve consumption is also low with an image problem

UK consumption ~0.1kg per capita per year compared to Spain ~5kg

RADIO 4 The Food Programme

Home Episodes Clips Galleries Podcast Presenters Food and Farm

Shellfish: A Very British Image Crisis

Clams and cockles. Delicacies across the world, but largely dodged in the UK. Meet a fisherman, a chef, a scientist and a food anthropologist trying to change your mind and diet.

Available now 29 minutes

Show more Download

<https://www.bbc.co.uk/sounds/play/m001qvw5>

BBC

YOU'RE READING

The simple food that fights climate change

By Rachel Lovell

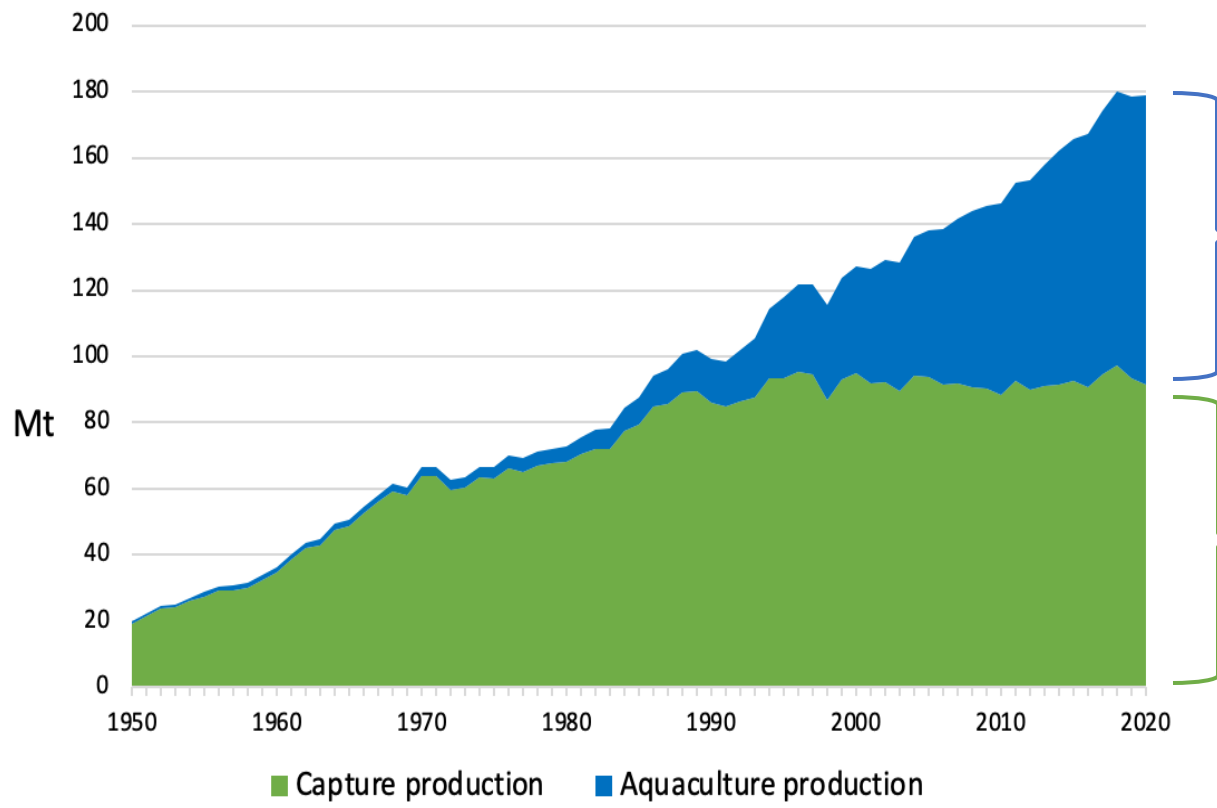
An unappreciated group of filter-feeding animals found around our coastlines could clean up our waters and nourish a billion people. Is it time we championed bivalves?

immering in pots around the world is a food that could spark a revolution. Most of us have

<https://www.bbc.com/future/bespoke/follow-the-food/the-simple-shellfish-that-fights-climate-change.html>

Wild fishing is at capacity and aquaculture is expanding unsustainably

Global fish & seafood production increase



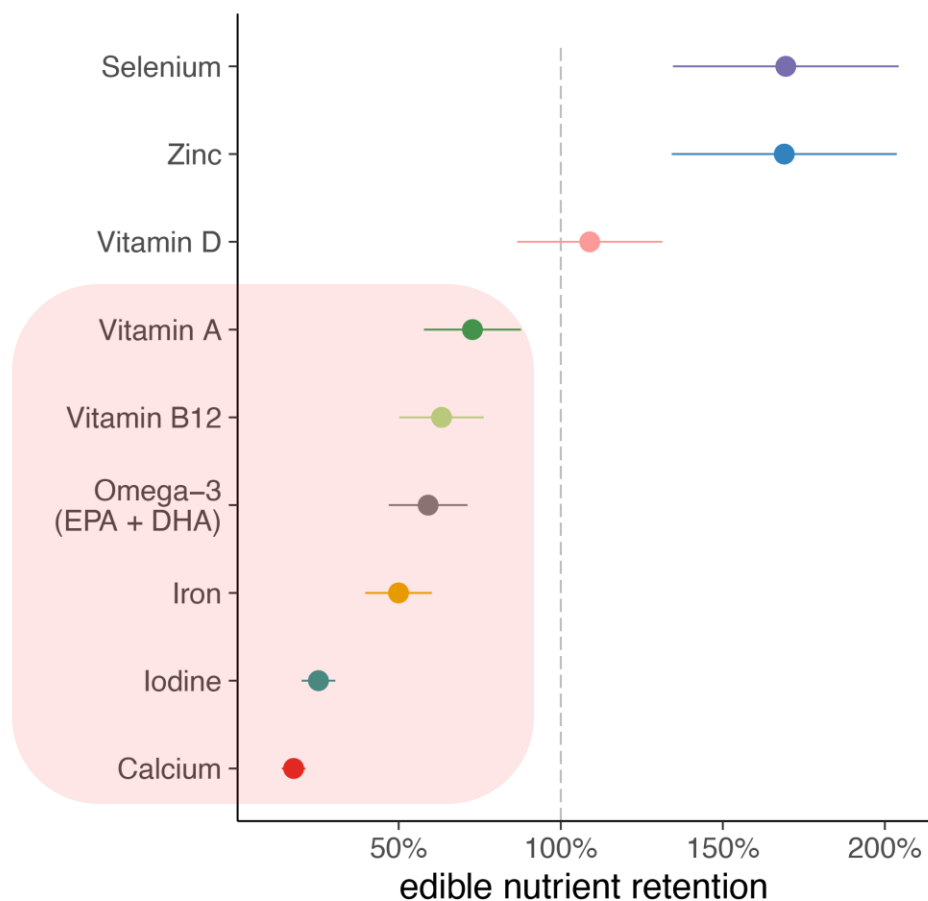
Global fish & seafood lack of sustainability

- **Aquaculture** is expanding fast
- **30%** of all **wild fish** caught go into **aquaculture feed** rather than human food
- Nutrient rich food being wasted
- **Wild fishing at capacity**
- **Catch static** since 1990 despite increased effort
- 80% of wild fish stocks fished to biological limit

FAO (2020)

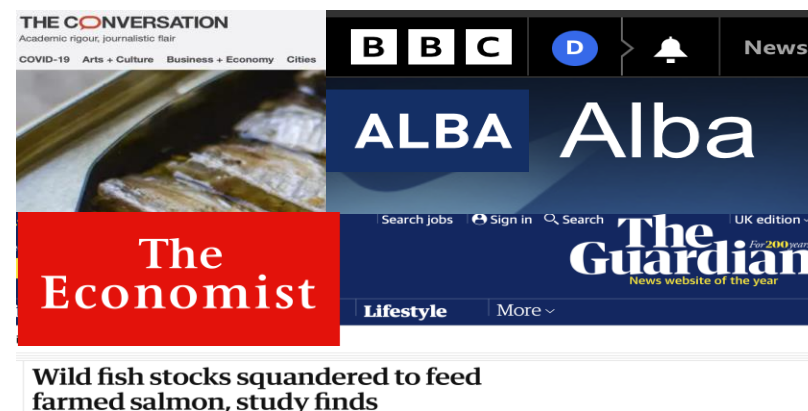
Industry metrics for tracking sustainability hide micronutrient loss

Edible nutrient retention in aquaculture



Willer, D.F., Robinson, J., Patterson, G. & Luyckx, K. (2022). Maximising sustainable nutrient production from coupled fisheries - aquaculture systems. *PLOS Sustainability and Transformation* 1(3): e0000005. <https://doi.org/10.1371/journal.pstr.0000005>

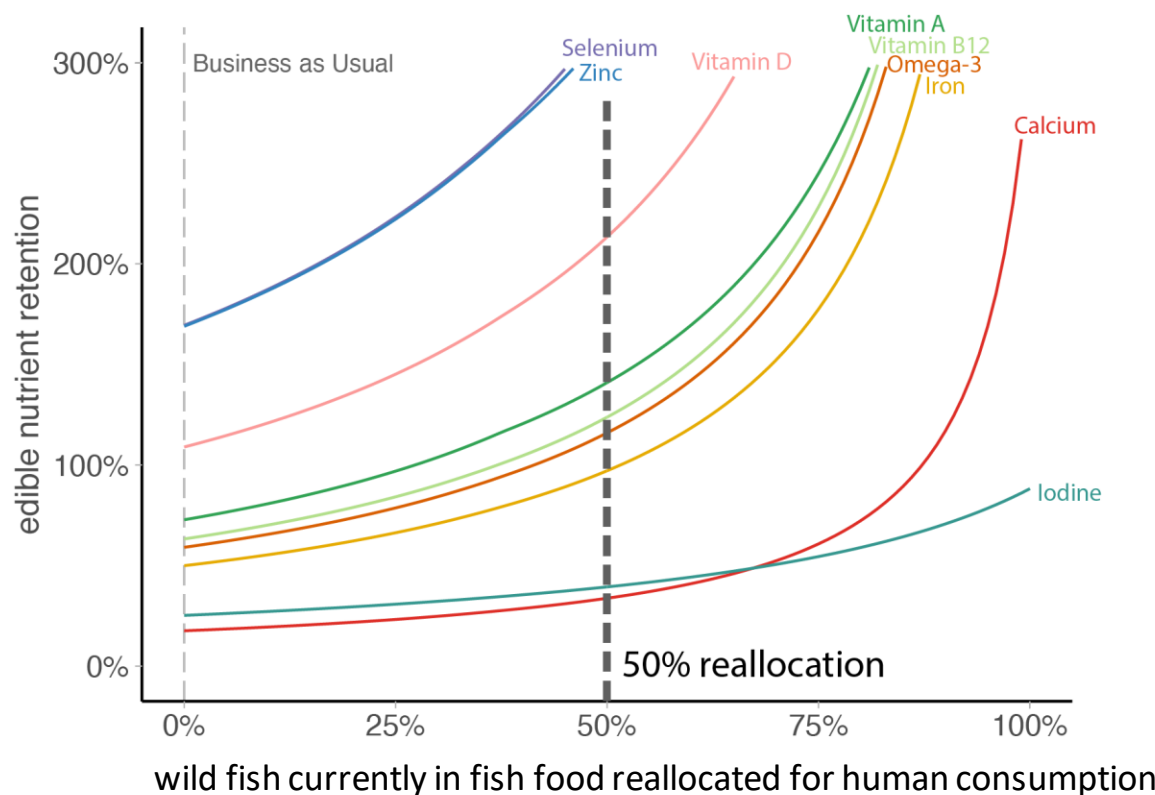
Our data has exposed micronutrient loss



- Farmed salmon are partly fed with wild fish. In 2020 in Norway, one of the largest and most sustainable producers, 2.1m tonnes of wild fish were reduced to fish oil and fish meal to produce 1.5m tonnes of salmon
- Aquaculture sustainability is typically assessed using Fish-In Fish-Out (FIFO) ratios, similar to the above statement, which ignore micronutrient loss
- A more appropriate metric, different feed and demand changes are needed for greater sustainability

Measures to increase direct consumption optimise micronutrient delivery to people

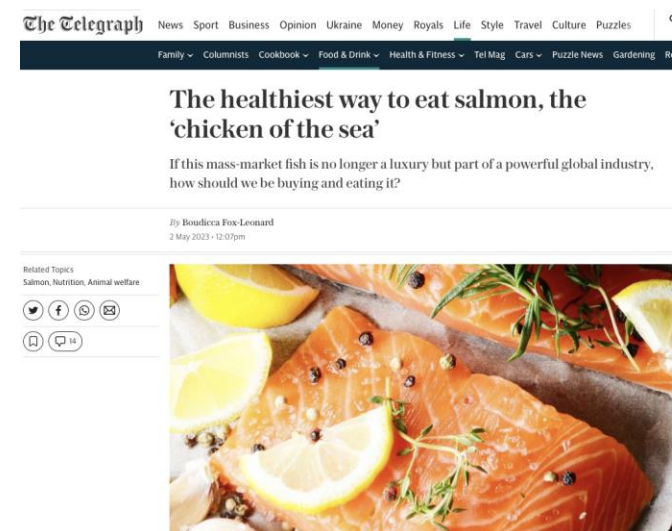
Our salmon model shows that reallocating for human consumption 50% of wild fish currently used in fish feeds brings edible nutrient retention to ~100% for vitamin A, vitamin B12, omega-3 and iron



Willer, D.F., Newton, R., Malcorps, W., Kok, B., Little, D., Lofstedt, A., de Roos, B., Robinson, J.P.W. *In Review*

Elements of a better direction for salmon aquaculture:

- Adoption of our new **edible nutrient retention** metric
- **Direct consumption** of wild fish instead of feeding to salmon to provide people with more micronutrients
- **Improved algal feeds** for salmon to substitute for wild fish
- **Appealing new food products** from wild fish and by-products that would have been in fish food

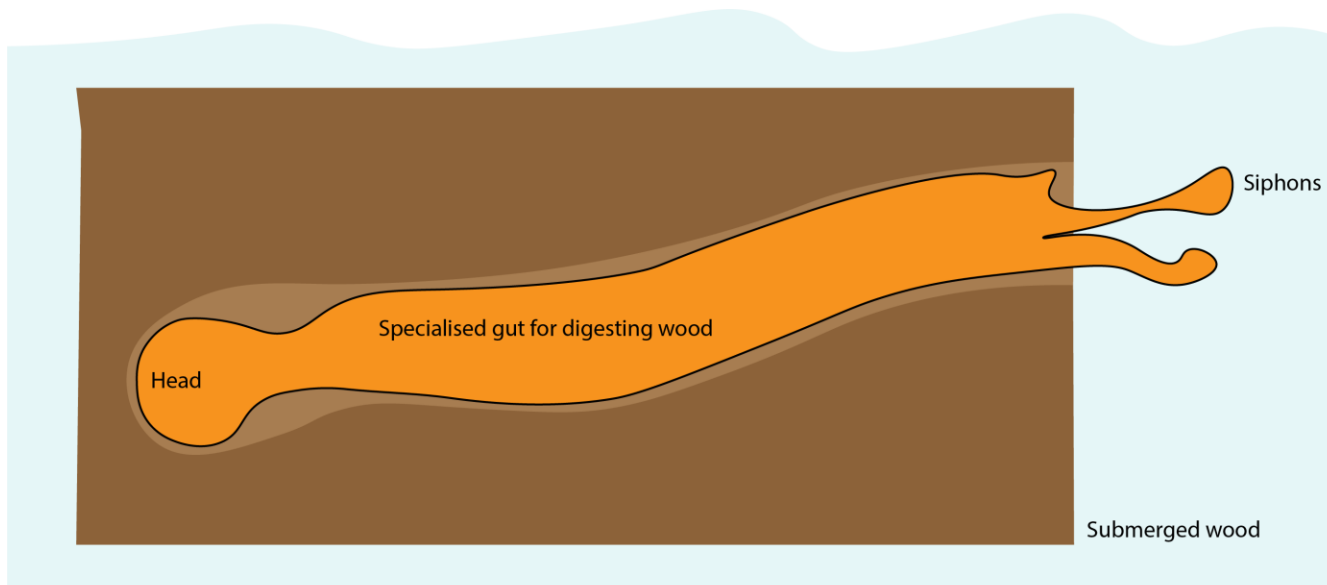


<https://www.telegraph.co.uk/food-and-drink/features/salmon-healthy-way-to-eat-chicken-of-the-sea/>

Aquaculture of novel species allows us to turn wood into protein

Novel species characteristics

- Shell-less clams burrow into wood instead of forming a shell, turning wood into protein and nutrients
- World's fastest growing bivalves – order of magnitude faster than conventional bivalves



Our research progress

- We have designed the first shell-less clam aquaculture system in the lab
- Ground-breaking experimental publication in review – details to be revealed
- Our work shows that these clams are:
 - Rich in B12
 - Rich in monounsaturated fats
 - High in protein
 - Fortified with omega-3
 - A candidate for a sustainable nutritious meat to put in mass-market foods

Willer, D. F., Aldridge, D. C., Mehrshahi, P., Papadopoulos, K., Archer, L., Smith, A., Lancaster, L., Strachen, A., Shipway, J.R. *In Review*

Willer, D. F. & Aldridge, D. C. (2020). From pest to profit - The potential of shipworms for sustainable aquaculture. *Frontiers in Sustainable Food Systems*, 4:575416. <https://doi.org/10.3389/fsufs.2020.575416>

Product innovation could drive mass market demand for bivalves and fish by-products

Nomad Foods
Europe



Engagement: In 2020 we begin collaboration with Nomad Foods, Europe's largest frozen food company and owners of Birds Eye, Findus and iglo.



Objective: Assess the potential for mass-market food products using bivalves

nature

Output: Major publication in December 2021 in *Nature Food* on 'Opportunities and challenges for upscaled global bivalve seafood production'

innoget

Impact: In April 2022 Nomad Foods launch Open Innovation Portal with the aim to bring bivalves into everyday meals within 2-3 years



Now: In discussion how to design and develop basic (e.g. minced, pureed), more complex (e.g. powdered), and advanced (e.g. textured extruded flavoured protein) mass-market bivalve, and fish by-product based processed food

<https://thefishsite.com/articles/frozen-food-giants-look-to-develop-farmed-shellfish-products-david-willer-cambridge>

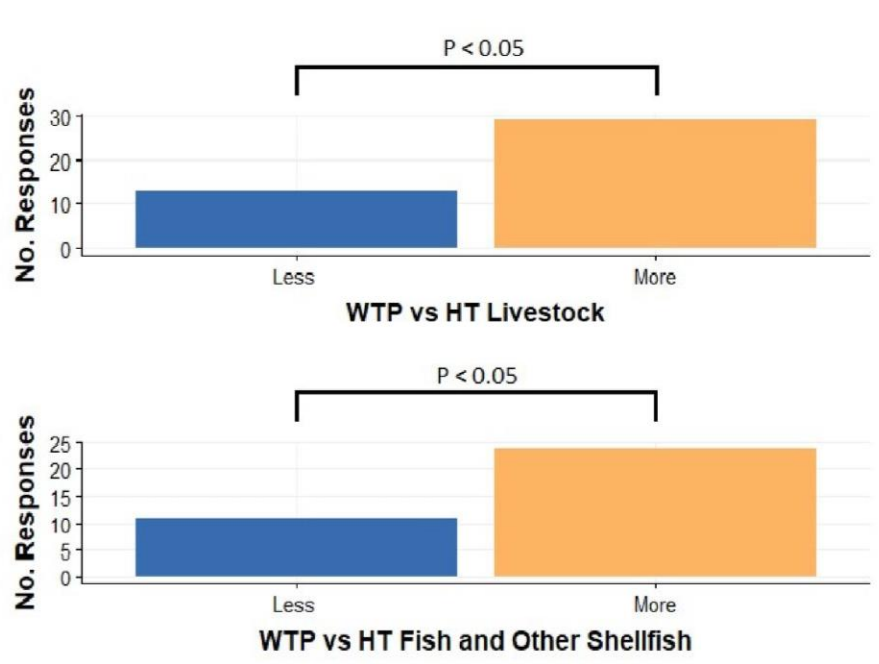
Willer, D. F., Nicholls, R.J. & Aldridge, D. C. (2021). Opportunities and challenges for upscaled global bivalve seafood production. *Nature Food*, 2(12): 935-943. <https://doi.org/10.1038/s43016-021-00423-5>

Selling bivalves in a processed form can drive switching from processed meat

People are willing to pay more for processed bivalve products than other processed meat or fish products

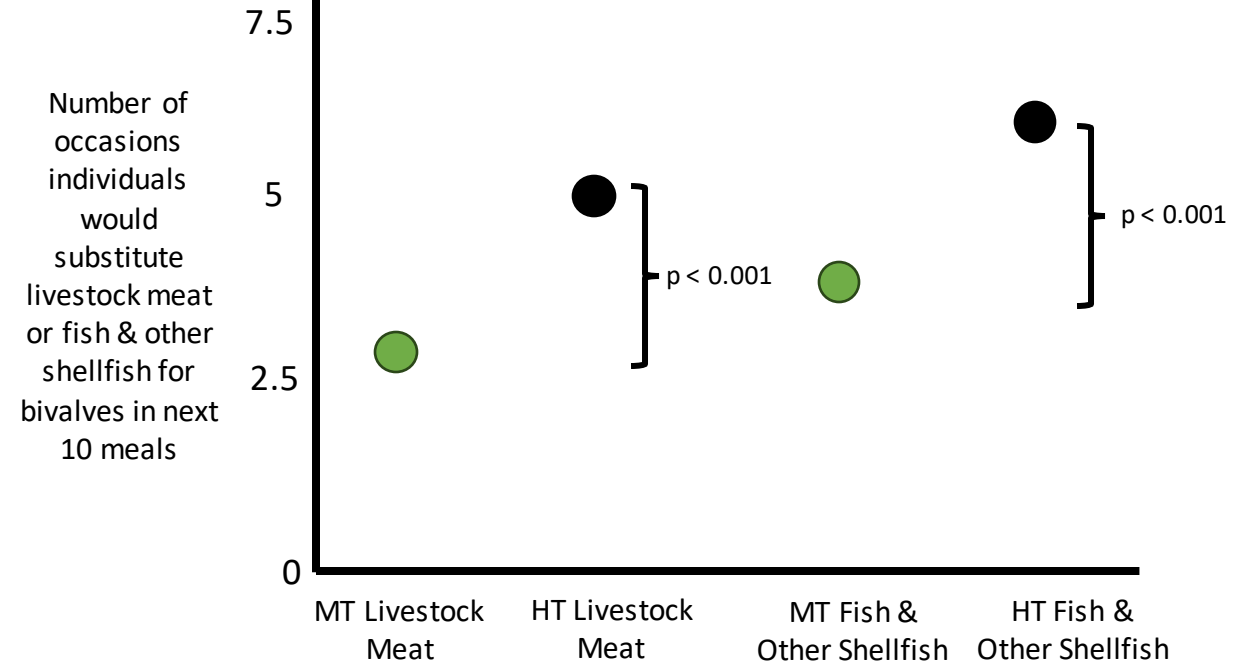
People are more willing to substitute processed meat or fish for bivalves than unprocessed meat or fish

Willingness to pay (WTP) for processed bivalves compared to processed livestock meat or processed fish & other shellfish



HT = highly transformed i.e. processed
 MT = minimally transformed i.e. unprocessed

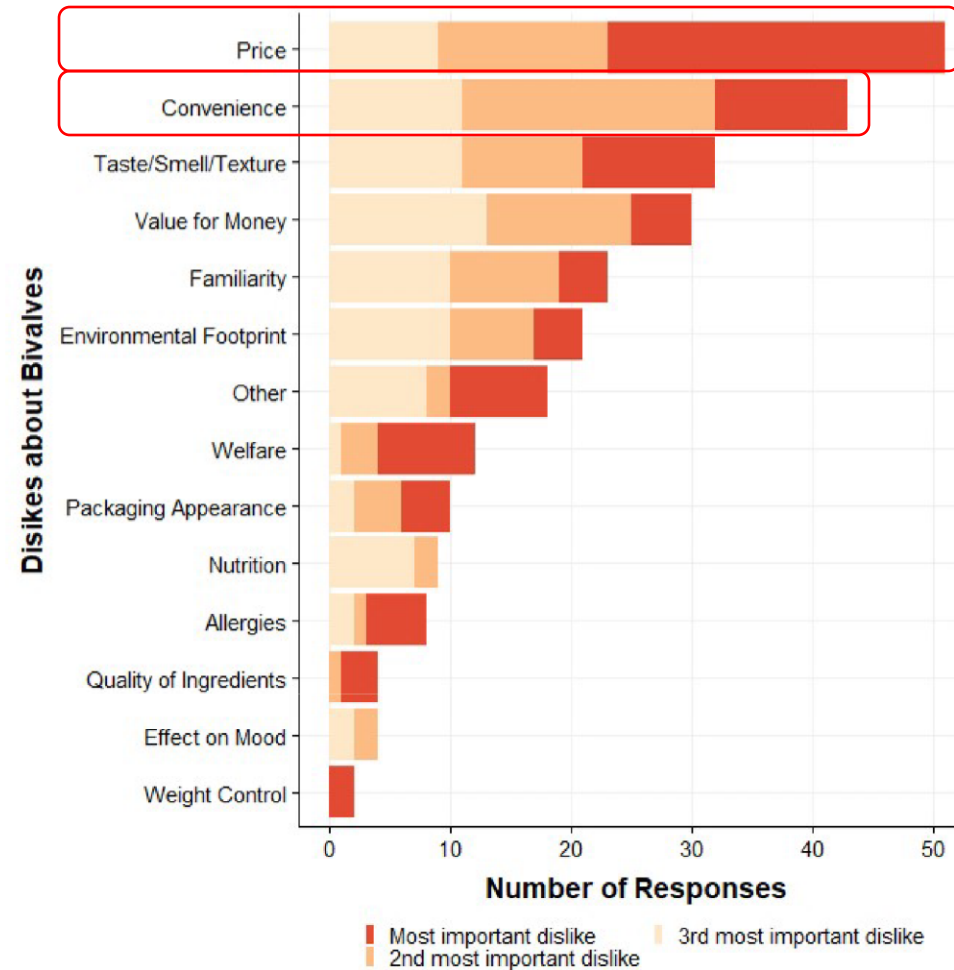
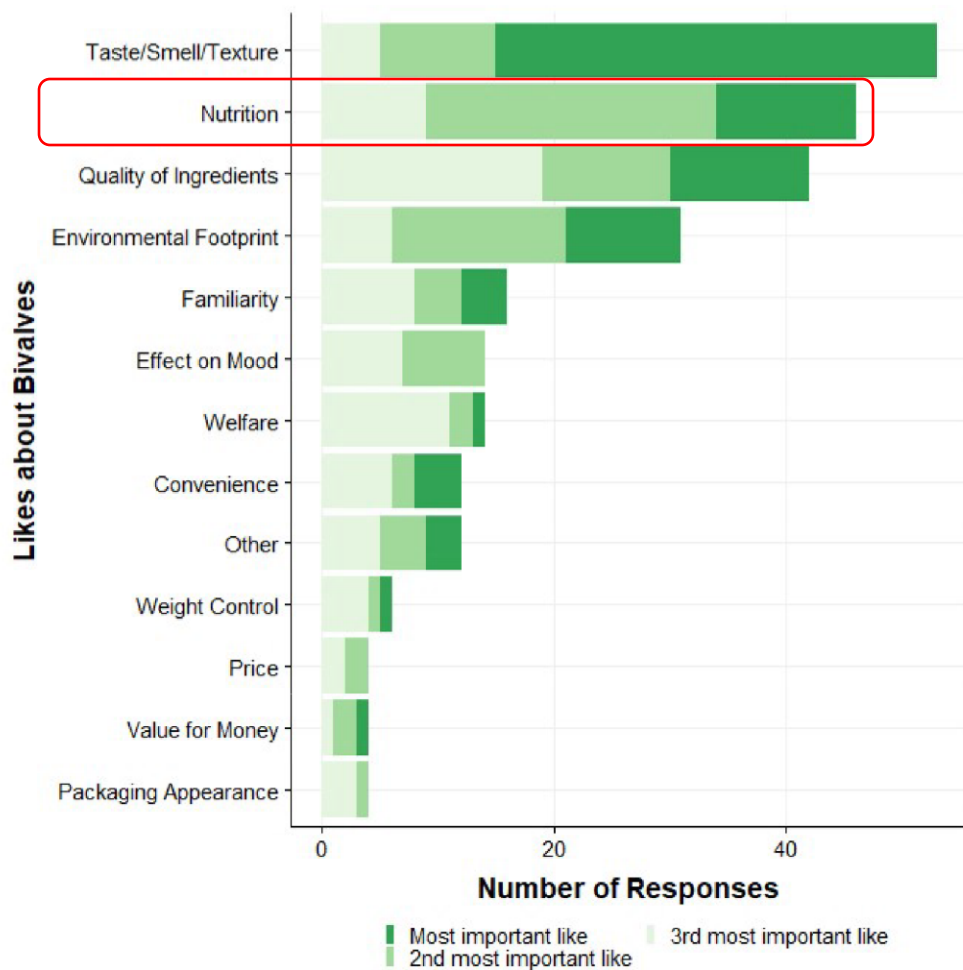
Willingness to substitute livestock meat or other fish and shellfish for Bivalves



Gawel, J. P. F., Aldridge, D. C., & Willer, D. F. (2023). Barriers and drivers to increasing sustainable bivalve seafood consumption in a mass market economy. *Food Frontiers*, 00, 1–14. <https://doi.org/10.1002/fft2.282>

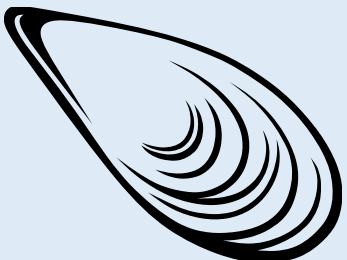
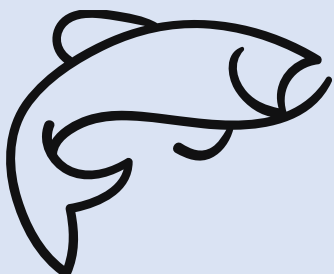


Nutrition, convenience and low price can drive greater sustainable bivalve consumption



Gawel, J. P. F., Aldridge, D. C., & Willer, D. F. (2023). Barriers and drivers to increasing sustainable bivalve seafood consumption in a mass market economy. *Food Frontiers*, 00, 1–14. <https://doi.org/10.1002/fft2.282>

Our research must help make direct human consumption economically attractive

	Business-as-usual	Sustainable Target	Why
<p>Bivalve aquaculture</p> 	<p>Financially unattractive to farm</p> <p>Fragmented producers</p> <p>Unpopular niche consumer product</p>	<p>Financially lucrative to farm</p> <p>Major players use innovation to drive consolidation and / or integration of the supply chain</p> <p>Popular mass-market product</p>	<p>Bivalves are the most sustainable and micronutrient dense meat on the planet. We need to realise their potential as a mass market food</p>
<p>Small fish & fish by-products</p> 	<p>Fisherman and farmers make more selling for fish/animal feed than food</p> <p>Supply chain dominated by manufacturers of fish oil & feed</p> <p>Few food products made from fish by-products available</p>	<p>Financially more attractive to sell for food than fish/animal feed</p> <p>Major players use innovative products to create an attractive market for human consumption</p> <p>Popular convenient mass-market products</p>	<p>Micronutrients from our valuable and limited wild fish supplies and fast growing aquaculture are being lost rather than being used to feed people</p>

Join us on our journey



Dr David Willer

Henslow Research Fellow, Murray Edwards College
E: dw460@cam.ac.uk
W: <https://www.zoo.cam.ac.uk/directory/david-willer>

