



Sustainable aquaculture through the One Health lens

Prof Grant D. Stentiford, Healthy Seafood Lead Cefas



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Healthy seafood



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Collaborating Centre for Emerging
Aquatic Animal Diseases



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Antimicrobial Resistance (AMR)



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Molluscs Sanitation

SUSTAINABLE AQUACULTURE FUTURES



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Protein from fisheries and aquaculture forms a significant element in global diet

Known and emerging disease is the biggest production hazard for sustainable global aquaculture



Protecting animal and human health.



Oie
WORLD ORGANISATION
FOR ANIMAL HEALTH



Microbial and chemical hazards present in seafood threaten the health of human consumers

Seafood consumption profiles differ by nation with risk dependent on current and future patterns



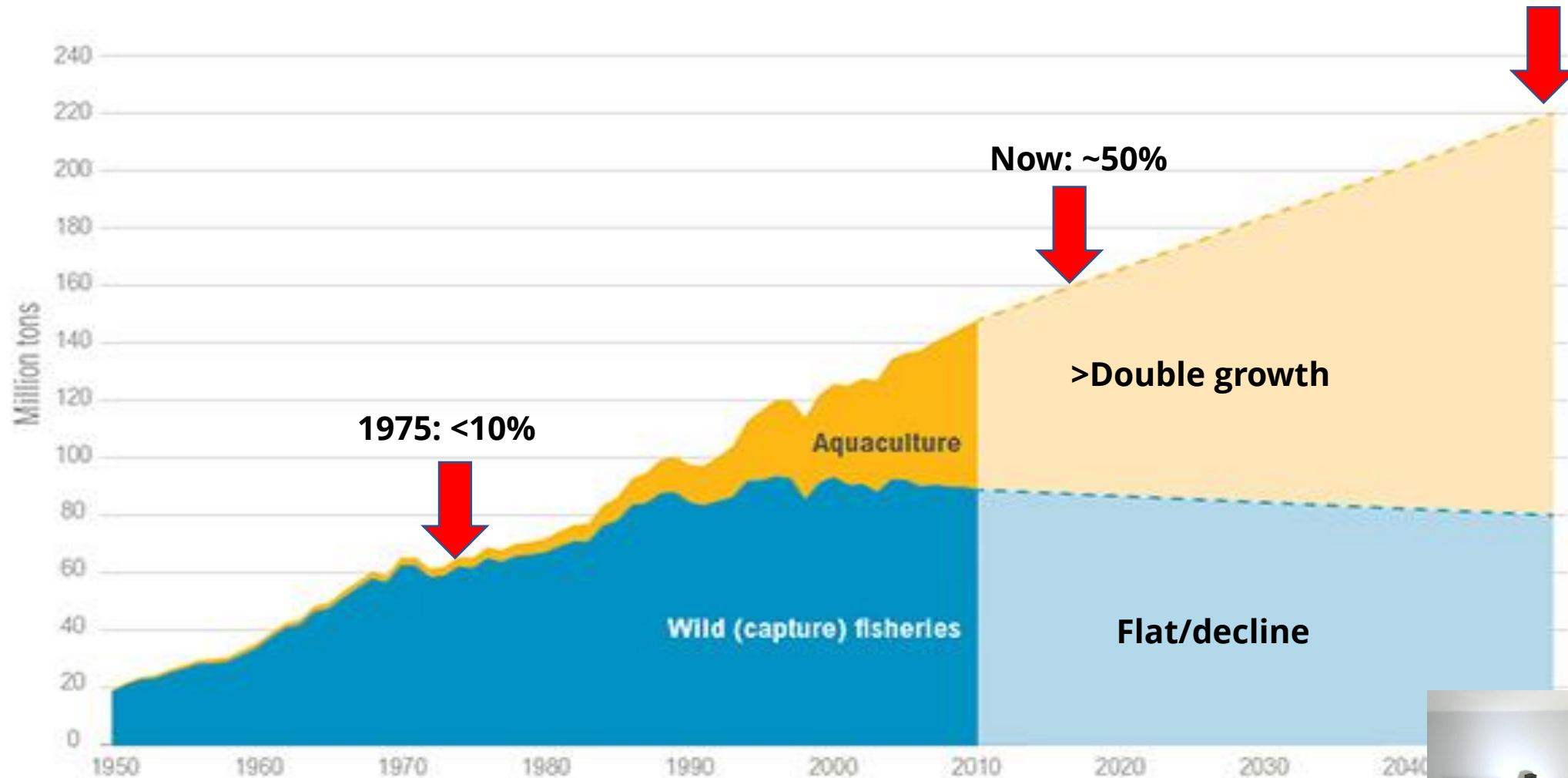
Food and Agriculture Organization
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of the United Nations

Aquaculture Is Expanding to Meet World Fish Demand

2050: 70%



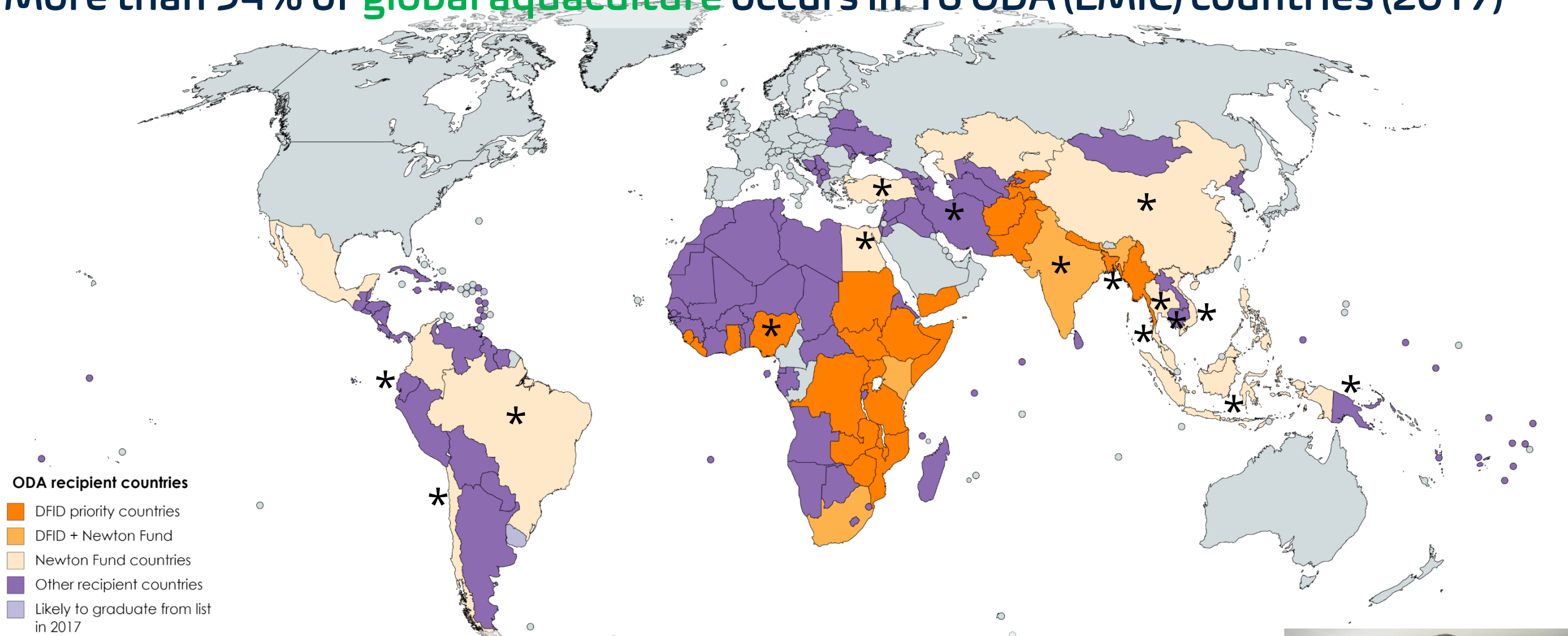
Source: Historical data 1950–2010: FAO. 2014. "FishStatJ." Rome: FAO. Projections 2011–2050: Calculated at WRI, assumes 10 percent wild fish catch between 2010 and 2050, and linear growth of aquaculture production at an additional 2 million tons per year between 2010 and 2050.

See www.wri.org/publication/improving-aquaculture for full paper.

 WORLD RESOURCES



More than 94% of **global aquaculture** occurs in 16 ODA (LMIC) countries (2017)

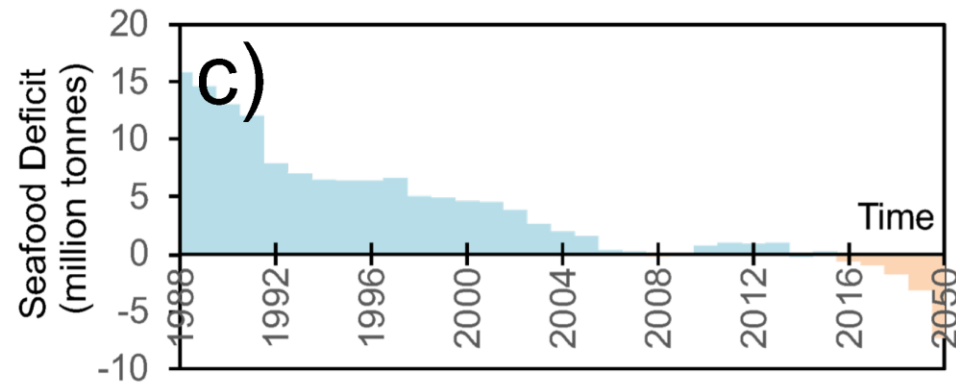


...with majority of industry expansion to 20



Mind the **gap**

...the majority of ICES nations lack **long-term strategies** for aquaculture, with few plans accounting for climate change and an increasing gap between future production and consumption – potentially **7 million tonne seafood deficit by 2050***



Understanding the potential for discrete aquaculture sectors to provide food should be a critical element in sustainable food production and consumption planning at individual nation level

2021 Thilsted



WORLD FOOD PRIZE FOUNDATION



Shakuntala Haraksingh Thilsted

TRINIDAD & TOBAGO AND DENMARK

Dr. Shakuntala Haraksingh Thilsted, native of Trinidad and Tobago and a citizen of Denmark, will receive the 2021 World Food Prize for her groundbreaking research, critical insights and landmark innovations in developing holistic, nutrition-sensitive approaches to aquaculture and food systems. By bringing together interdisciplinary and international collaborators, she drove transformations in aquatic food systems to deliver improved nutrition, resilient ecosystems and secure livelihoods for millions of vulnerable people across the globe.

Dr. Shakuntala Haraksingh Thilsted, Global Lead for Nutrition and Public Health, WorldFish, said, "I am truly honored to receive the 2021 World Food Prize, and I am deeply humbled to be placed in such distinguished ranks as those of past laureates. Aside from personal joy and gratitude, as a scientist, I feel this award is an important recognition of the essential but often overlooked role of fish and aquatic food systems in agricultural research for development. Fish and aquatic foods offer life-changing opportunities for millions of vulnerable women, children, and men to be healthy and well-nourished."



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Sustainability is not a given

BEHIND THE WORLD'S AQUACULTURE LEADER FOR 11 YEARS

aquaculture

magazine

(History, Geography, Science, Culture)



FARMED FISH ESCAPES

OFFSHORE AQUACULTURE
WHAT KIND OF "GONE" ARE WE TALKING ABOUT HERE?

SALMONIDS
MAIN FACTORS BEHIND ESCAPES OF FARMED SALMON AND TROUT



일본 수산물 WTO 분쟁 국민안전이 승리했다

2019년 4월 12일(금) 오전 11시 / 광화문 정부종합청사 앞

일본산 수산물 수입 대응 시민 네트워크

Members of a South Korean citizens' group applaud Friday in Seoul following the World Trade Organization's decision in favor of continuing an import ban on Japanese seafood. Photo: Morgabay

NATIONAL


WTO upholds South Korea ban on some Japan seafood imports over Fukushima nuclear disaster

ASIA TIMES

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MYOUBO | ENVIRONMENT

MAY 4, 2019



Mangroves are regarded as powerhouses of carbon storage. Photo: Morgabay

Shrimp farms threaten Myanmar's remaining mangroves

Salmon farming in crisis: 'We are seeing a chemical arms race in the seas'

Rare only 40 years ago, farmed salmon is now taken for granted in our kitchens. But the growth of the industry has come at great cost




The salmon farming industry has grown at breakneck speed since the 1970s. Photograph: Alamy

Every day, salmon farmers across the world walk into steel cages - in the seas off Scotland or Norway or Iceland - and throw in food. Lots of food; they must feed tens of thousands of fish before the day is over. They must also check if there are problems, and there is one particular problem they are coming across more and more often. Six months

Australian Marine Conservation Society

PROTECTING AUSTRALIA'S OCEAN WILDLIFE SINCE 1965



RED RATING FOR TASMANIAN FARMED ATLANTIC SALMON: INDUSTRY PUSHING ENVIRONMENT TOO FAR, TOO FAST

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NEWS > LOCAL NEWS

Californians warned not to eat certain oysters after outbreak of illness

Posted: 1:42 PM, May 07, 2019 Updated: 9:42 PM, May 07, 2019 By: Zac Self



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Environment

Wild salmon population 'at crisis point' with catches in Scotland at lowest level on record

Open-net farming blamed for rise in parasitic sea lice affecting wild stocks

Harry Cockburn | Wednesday 24 April 2019 06:15 | 112 comments



Wild Scottish salmon has been off the news since December 2018 when the country's last rating station closed down due to lack of fish. Getty

guardian

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Shrimp sold by global supermarkets is peeled by slave labourers in Thailand

An investigation follows the trail of shrimp prepared by captive workers in squalid factories into the supply chain for food outlets in the US, Asia and Europe




2,684 views | May 6, 2019, 08:00am

It's Time For Aquaculture To Start Kicking Its Drug Habit

Maisele Gantzier Contributor

Food & Drink

I never feed sustainability, especially as it relates to seafood.



undercurrent news

established business news from beneath the surface

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AQUACULTURE | COMPANIES | DRUGS

Indian shrimp farmers need to move away from antibiotics, says industry leader

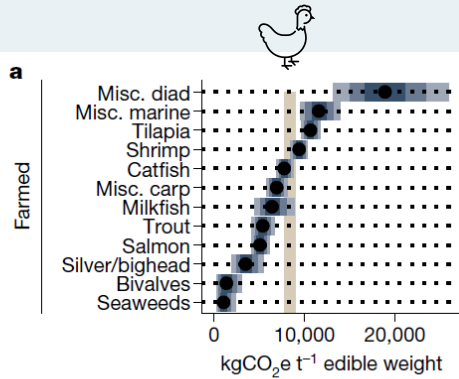
By Undercurrent News May 6, 2019 09:03 BST



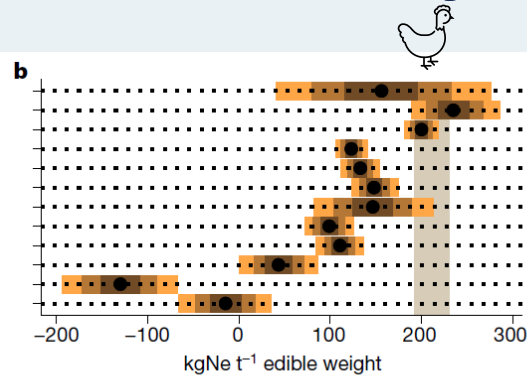


Relative performance

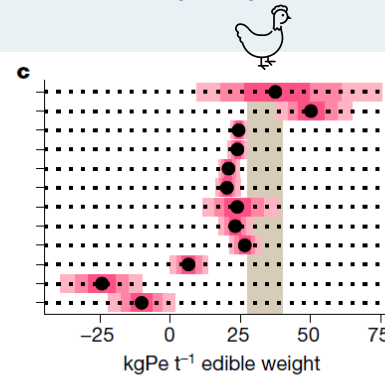
Emissions (A)



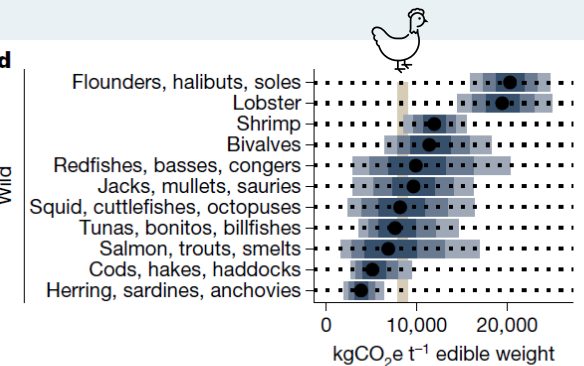
nitrogen



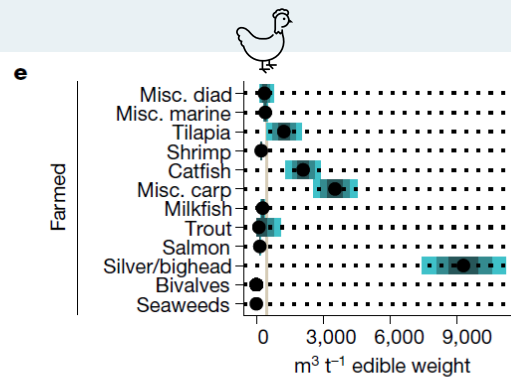
phosphorus



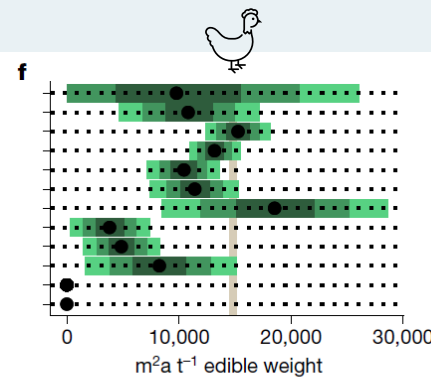
Emissions (F)



Water use



land use



Standardised 'stressor' method

GHG, N, P, FW use, land use per tonne edible weight

Used chicken as benchmark

Non-fed/extractive species lowest

Fed aquaculture emissions mainly from feeds, fishery emissions mainly from fuel

Gephart et al. (2021). Environmental performance of blue food. Nature 597, 360-366



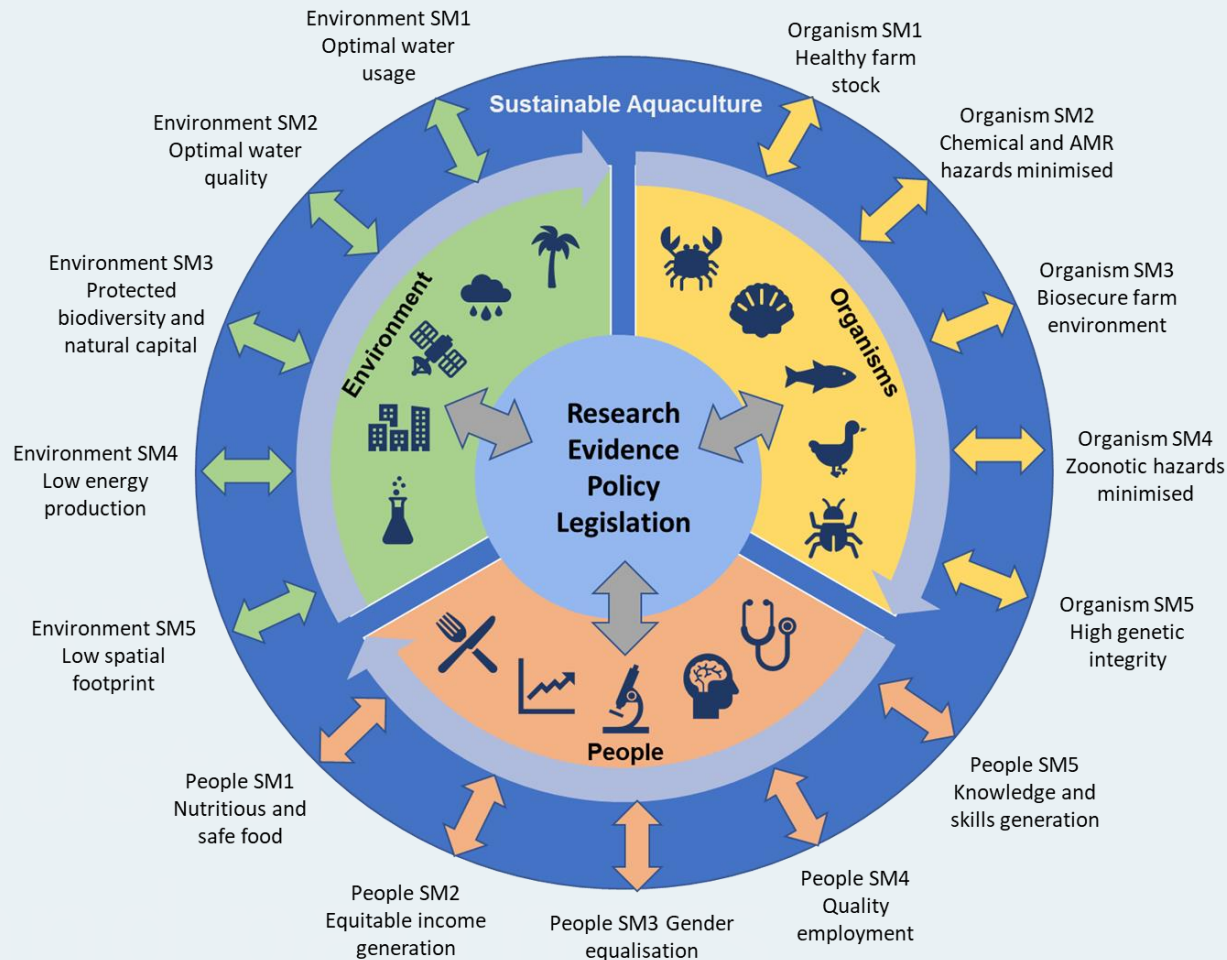
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Volume 1 Issue 8, 1 August 2020



One Health aquaculture

Aquaculture, the farming of aquatic animals and plants, is one of the fastest developing food sectors globally, and in recent years has become the main source of fish available for human consumption. Applying the principles of One Health – the interconnectedness of human, animal and planetary health – could well support enhanced sustainable production in aquaculture; facilitating food and nutrition security, poverty alleviation, economic development and the protection of natural resources.

See Stentiford et al. [show less](#)

One Health aquaculture - everyone's business

'Aquaculture has evolved into a major global food sector. Rapid growth necessitates an evidence and policy makeover fit for a doubling of output by 2050. A One Health approach, drawing on a broad expertise outside of traditional aquatic disciplines is now needed to realise it's full potential'

<https://sustainabilitycommunity.springernature.com>



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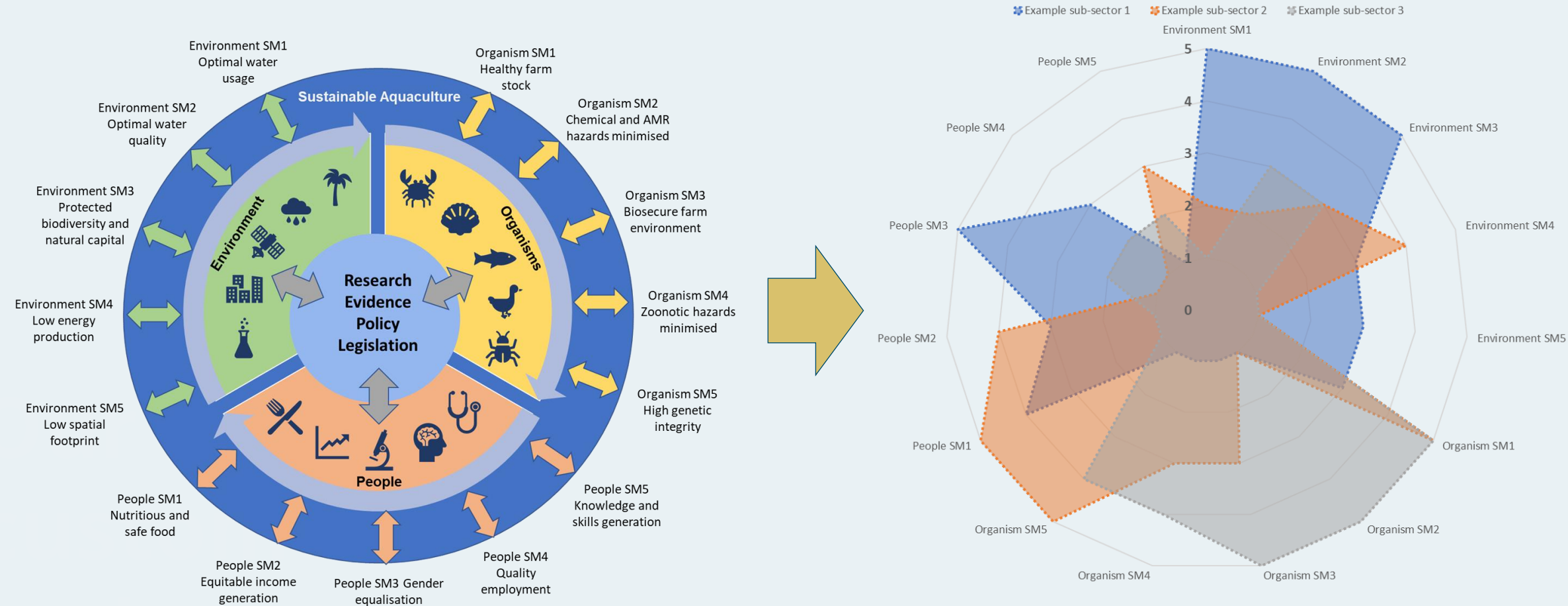
*Stentiford, G.D. et al (2020). *Sustainable aquaculture through the One Health lens*. Nature Food 1, 468–474

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A policy-evidence **makeover**



*Stentiford, G.D. et al (2020). *Sustainable aquaculture through the One Health lens*. Nature Food 1, 468–474



Priority setting

'You've used up potentially large amounts of resource to get absolutely nowhere'

- **Animal health and food safety** are critical **early elements** in any OHA strategy
- Capacity to **detect and control** for known/new **hazards** underpins stable and safe production/trade
- Failure to control creates **instability** and utilises significant animal-human-environment **capital** without tangible outcome (food/income)

Sustainable nutrition outlook



Seaweed farmers in Tanzania tend to their crops. Not only is seaweed a nutritious food

As aquaculture is scaled up, the problem of disease will also become greater. "As you expand the volume of production, you are going to get significant losses," says Grant Stentiford, a pathologist and head of aquatic animal health at the Centre for Environment Fisheries and Aquaculture Science, Weymouth, UK. "You've used up potentially large amounts of resource to get absolutely nowhere."

Cultivating a sea change

Can aquaculture overcome its sustainability challenges to feed a growing global population? By Sarah DeWeerd

Nature 588, S60-62

www.nature.com/articles



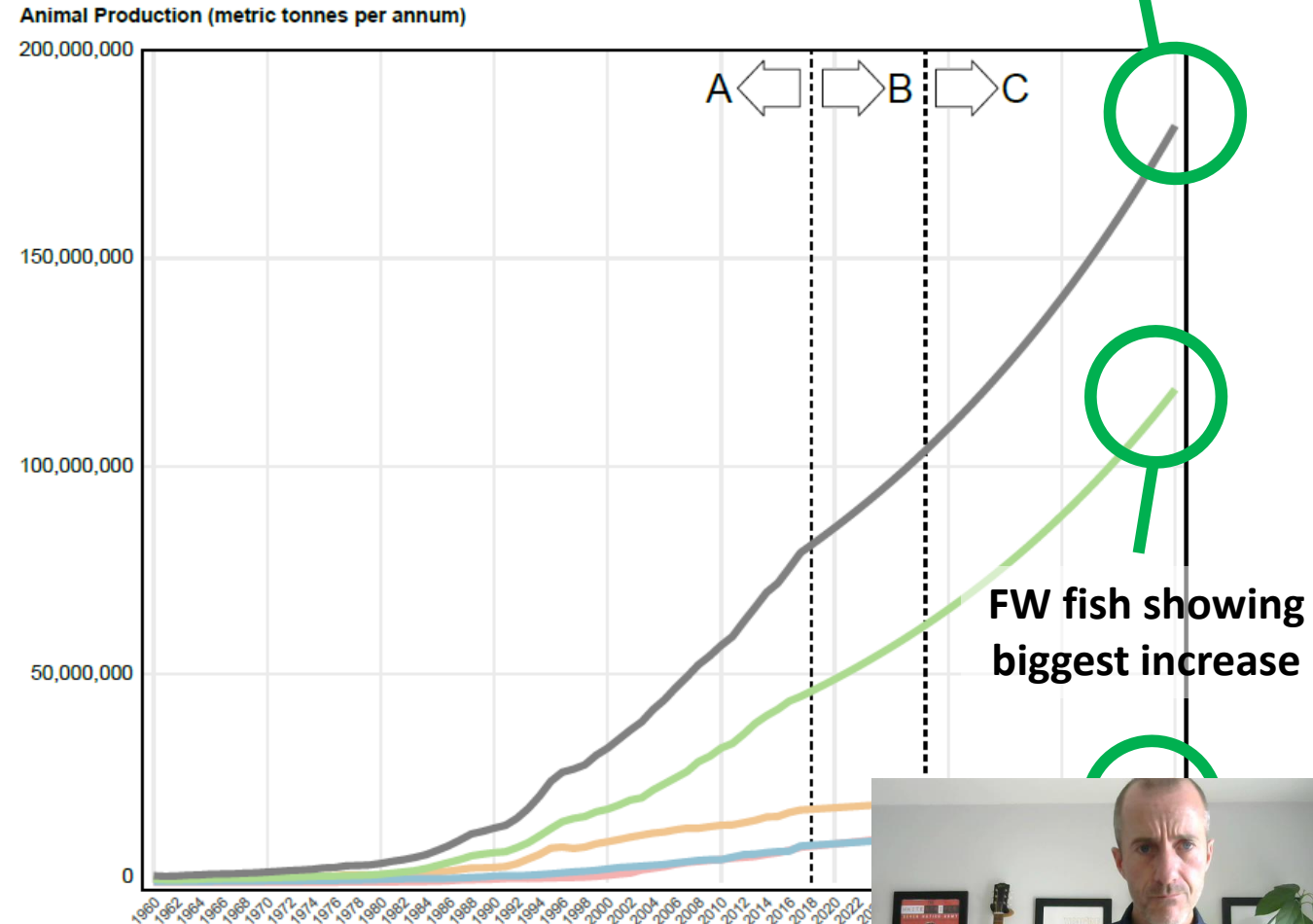
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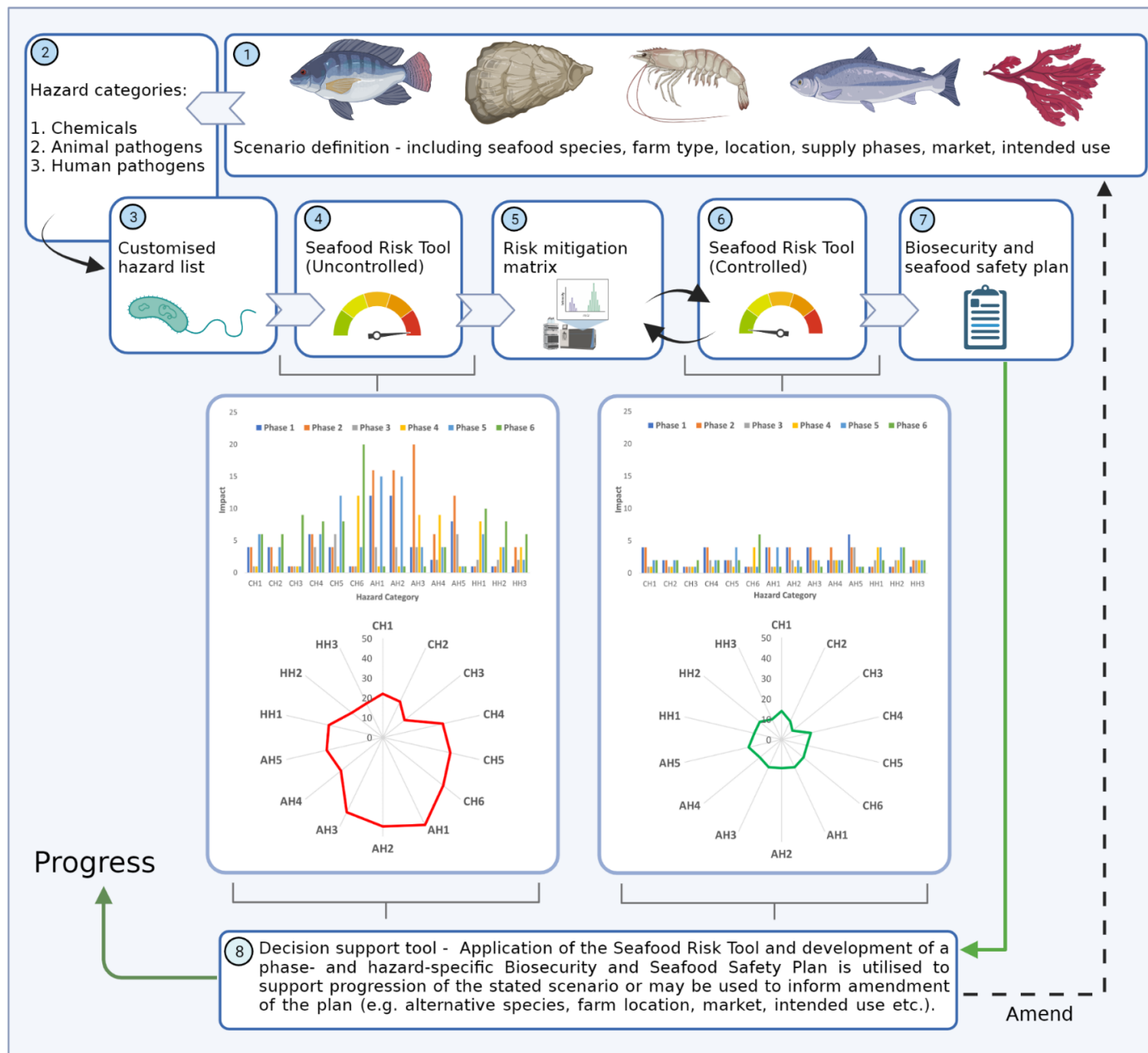
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Aquaculture doubling by 2050



A man with short, light-colored hair and a serious expression stands in a room. He is wearing a dark blue button-down shirt over a white t-shirt. Behind him, a yellow acoustic guitar is mounted on a light-colored wall. To the left of the guitar is a framed poster of a person in a red and white striped shirt. To the right of the guitar is a framed picture with text. A green plant is visible on the far right. The man is pointing his right index finger towards the camera.



'While predominant scientific, policy and public discourse has orientated around the potential impact of aquaculture on aquatic systems, much less consideration has been paid to the impact that land-based human activities have on contaminating those aquatic habitats that will be increasingly relied upon to provide human dietary protein in coming decades'

Emergency harvest at shrimp farm, Thailand, 2018

A perspective on health and disease



The past 20

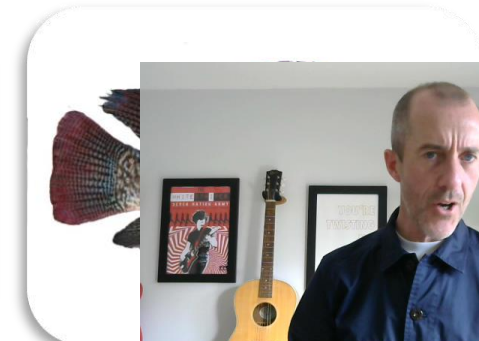
Health, infection and disease in...



Wild and farmed crustaceans



Wild and farmed molluscs



Wild and farmed

Some specifics

Enterospora canceri n. gen., n. sp., intranuclear within the hepatopancreatocytes of the European edible crab *Cancer pagurus*

G. D. Stentiford^a, K. S. Bateman, M. Longshaw, S. W. Feist



Decay of the glycolytic pathway and adaptation to intranuclear parasitism within Enterocytozoonidae microsporidia



Dominic Wiredu Boakye,¹ Pattana Jaroenlak,^{2,3} Anuphap Prachumwat,⁴ Tom A. Williams,⁵ Kelly S. Bateman,⁶ Ornthuma Itsathitphaisarn,^{2,3} Kallaya Sritunyalucksana,⁴ Konrad H. Paszkiewicz,¹ Karen A. Moore,¹ Grant D. Stentiford^{6*} and Bryony A. P. Williams^{1*}

A Nested PCR Assay to Avoid False Positive Detection of the Microsporidian *Enterocytozoon hepatopenaei* (EHP) in Environmental Samples in Shrimp Farms

Pattana Jaroenlak^{1,2}, Piyachat Sanguanrut^{2,3}, Bryony A. P. Williams⁴, Grant D. Stentiford⁵, Timothy W. Flegel^{2,6}, Kallaya Sritunyalucksana^{3,6}, Ornthuma Itsathitphaisarn^{1,2*}



Enterocytozoon hepatopenaei sp. nov. (Microsporida: Enterocytozoonidae), a parasite of the black tiger shrimp *Penaeus monodon* (Decapoda: Penaeidae): Fine structure and phylogenetic relationships

Somjintana Tourtip^a, Somjai Wongtripop^b, Grant D. Stentiford^c, Kelly S. Bateman^c, Siriporn Sriurairatana^d, Jittipan Chavadej^a, Kallaya Sritunyalucksana^d, Boonsirm Withyachumnarnkul^{a,d,*}



Hepatospora eriocheir (Wang and Chen, 2007) gen. et comb. nov. infecting invasive Chinese mitten crabs (*Eriocheir sinensis*) in Europe

G.D. Stentiford^{a*}, K.S. Bateman^a, A. Dubuffet^b, E. Chambers^a, D.M. Stone^a



The shrimp microsporidian *Enterocytozoon hepatopenaei* (EHP): Biology, pathology, diagnostics and control

Thawatchai Chaijarasphong^{a,b}, Natthinee Munkongwongsiri^c, Grant D. Stentiford^{d,e}, Diva J. Aldama-Cano^{a,c}, Kwanta Thansa^c, Timothy W. Flegel^{a,f}, Kallaya Sritunyalucksana^c, Ornthuma Itsathitphaisarn^{a,g,*}

PEARLS

Ultimate opportunists—The emergent *Enterocytozoon* group Microsporidia

Grant D. Stentiford^{1,2*}, David Bass^{1,2,3}, Bryony A. P. Williams^{2,4}

Now >100 publications on EHP....



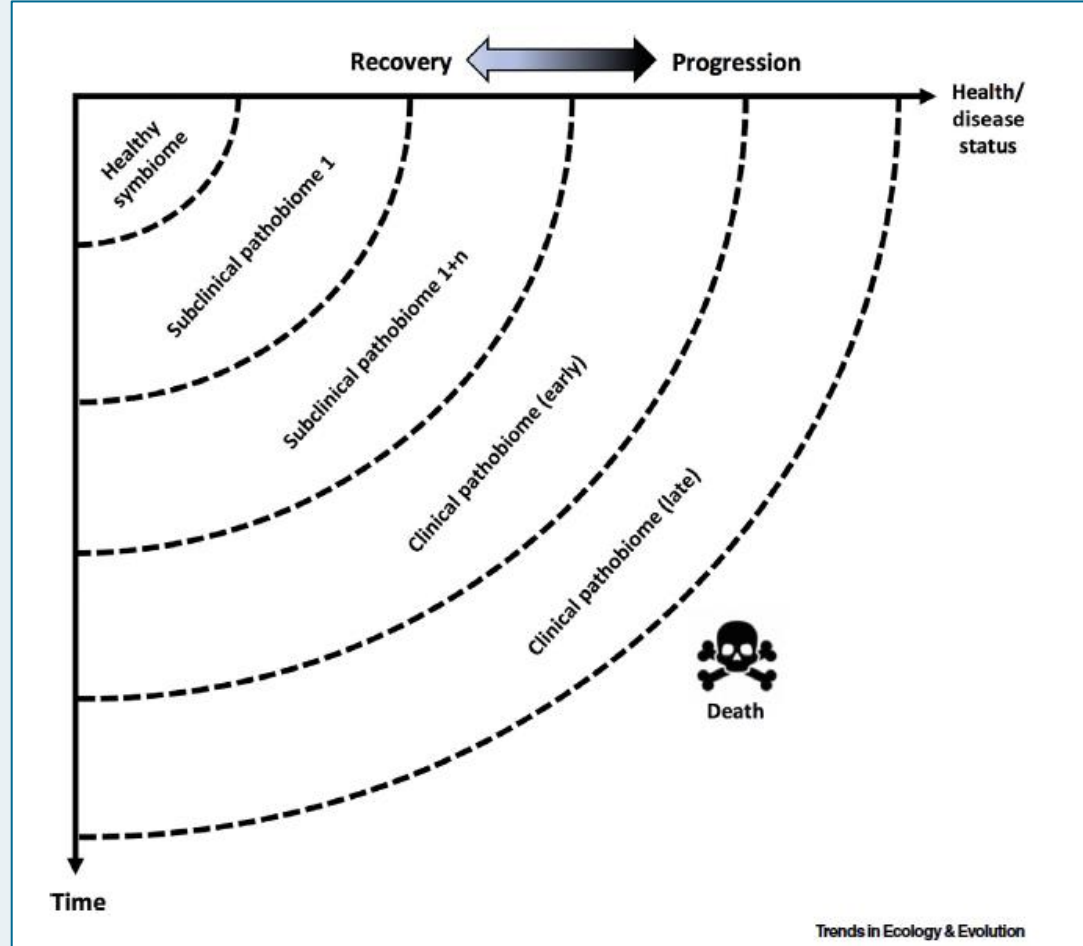
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The next 20?



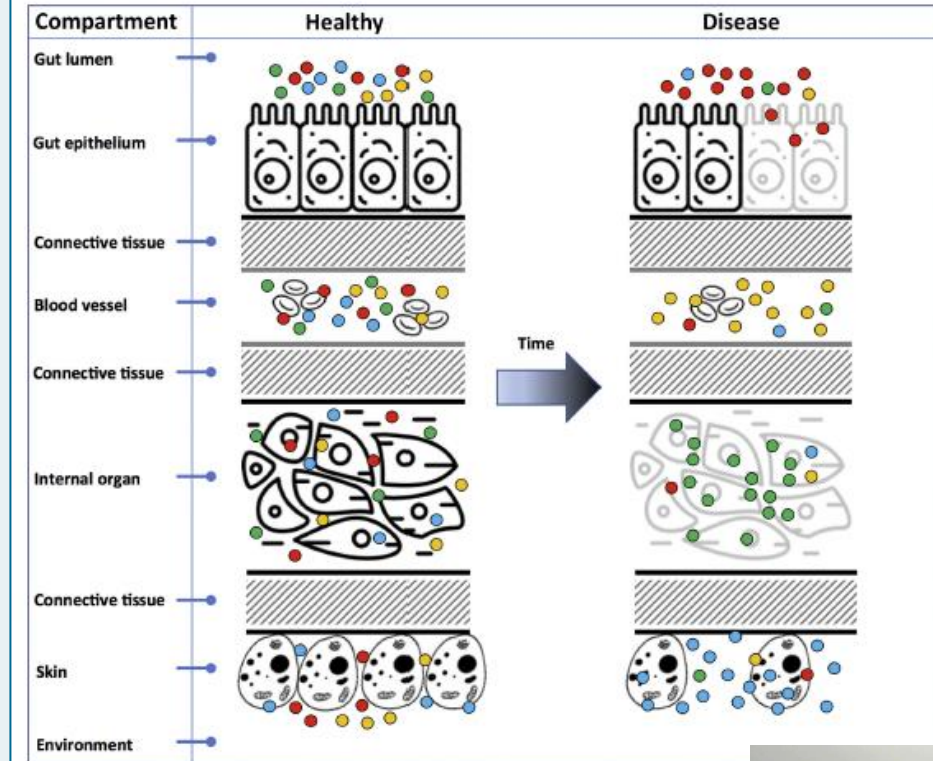
Trends in Ecology & Evolution

CellPress
REVIEWS

Review

The Pathobiome in Animal and Plant Diseases

David Bass,^{1,2,3,*} Grant D. Stentiford,^{1,2,®} Han-Ching Wang,^{4,5,®} Britt Koskella,^{6,®} and Charles R. Tyler^{2,7}



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Article

A Novel RNA Virus, *Macrobrachium rosenbergii* Golda Virus (MrGV), Linked to Mass Mortalities of the Larval Giant Freshwater Prawn in Bangladesh

Chantelle Hooper ^{1,*}, Partho P. Debnath ^{2,*}, Sukumar Biswas ³, Ronny van Aerle ^{1,4}, Kelly S. Bateman ^{1,4}, Siddhawartha K. Basak ², Muhammad M. Rahman ², Chadag V. Mohan ⁵, H. M. Rakibul Islam ⁶, Stuart Ross ¹, Grant D. Stentiford ^{1,4}, David Currie ³ and David Bass ^{1,4,7}

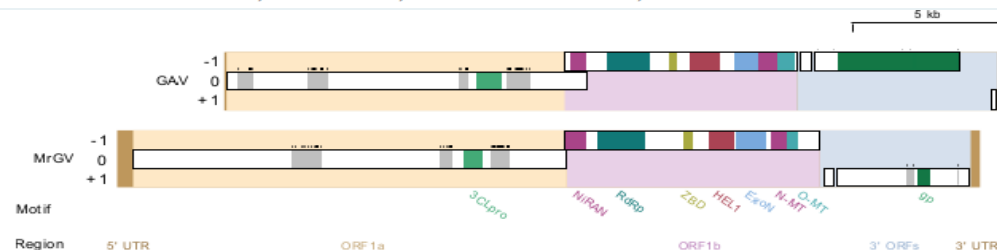
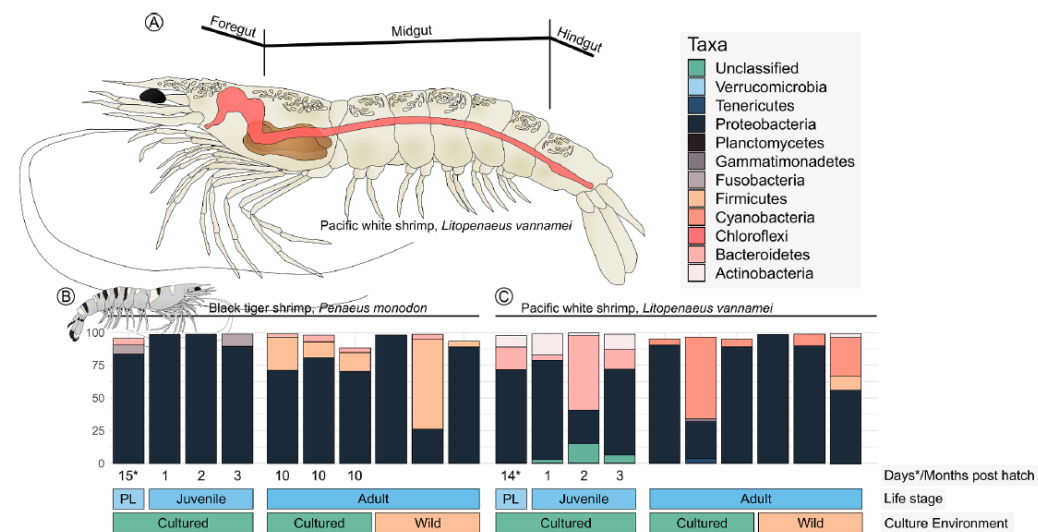


Figure 3. Schematic illustration of linear *Macrobrachium rosenbergii* Golda Virus (MrGV) and gill-associated virus (GAV) genomes and proteomes. Open reading frame (ORF) 1a is set as reading frame zero and genomes are split into five sections: 5' untranslated region (UTR), ORF1a, ORF1b, 3' ORFs and 3' UTR. Transmembrane (TM) regions are shown in grey with predicted TM helices shown as black bars above these regions. Predicted protein motifs are a 3C-like protease (3CLpro), nidovirus RdRp-associated nucleotidyltransferase (NiRAN), RNA-dependent RNA polymerase (RdRp), zinc-binding domain (ZBD), superfamily 1 helicase (HEL1), 3'-5' exoribonuclease (ExoN), S-adenosylmethionine (SAM)-dependent N7- and 2'-O-methyltransferases (N-MT and O-MT, respectively) and glycoproteins (gp).

Use of sequencing technologies to detect and describe cryptic pathogens

Understanding the role of the shrimp gut microbiome in health and disease

Corey C. Holt ^{a,b,c,d,*}, David Bass ^{a,c}, Grant D. Stentiford ^{a,c}, Mark van der Giezen ^{b,c,e,*}



Shift to focus on microbial conditions conducive to health rather than just disease

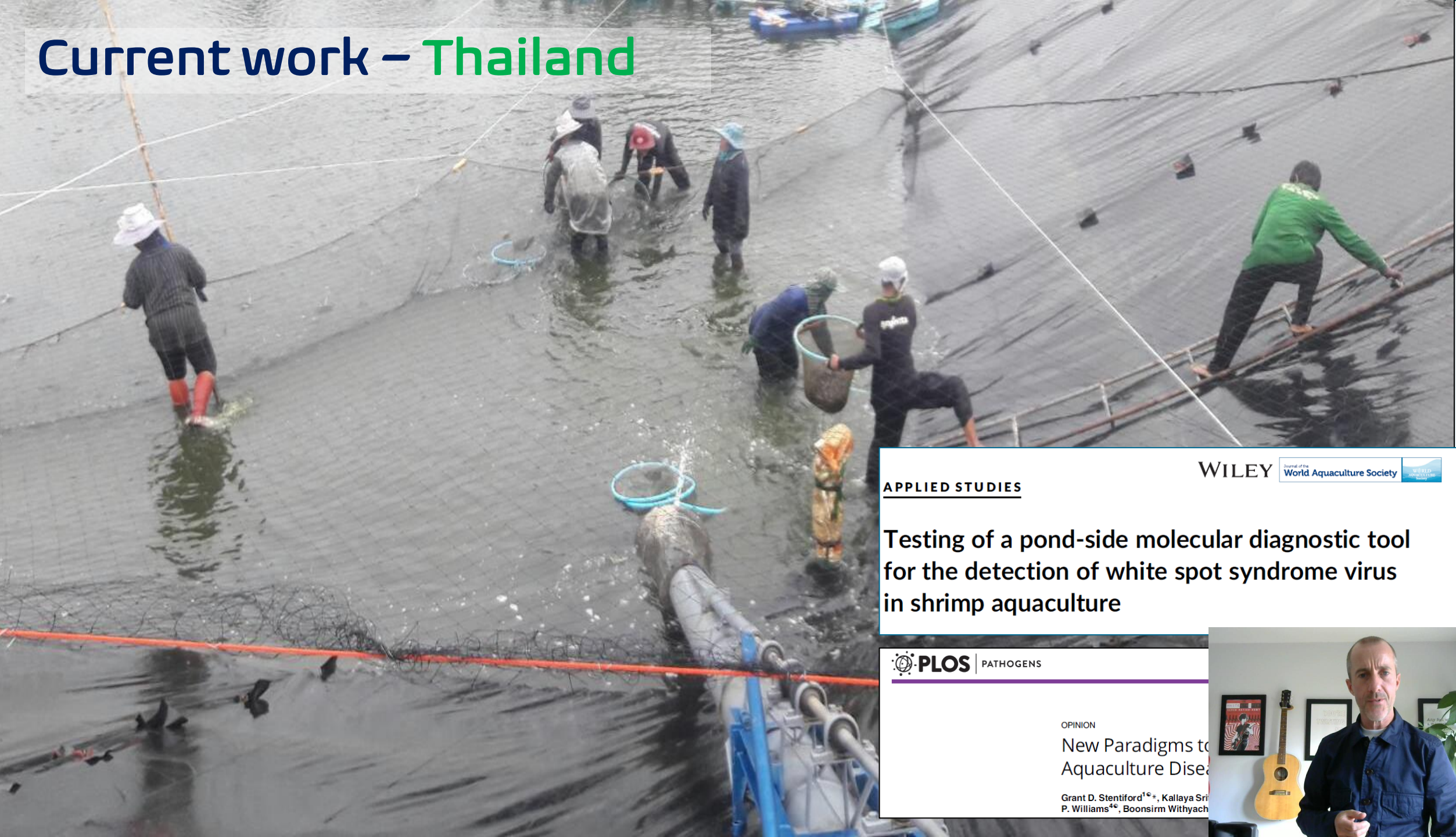




**EMBEDDING ONE HEALTH TO
SUPPORT A
PRODUCTION DURING**



Current work – Thailand



APPLIED STUDIES

WILEY Journal of the World Aquaculture Society WORLD AQUACULTURE SOCIETY

Testing of a pond-side molecular diagnostic tool for the detection of white spot syndrome virus in shrimp aquaculture

PLOS PATHOGENS

OPINION

New Paradigms to Aquaculture Disease


Grant D. Stentiford¹*, Kallaya Sri P. Williams⁴*, Boonsirm Withyach



Current work – Tanzania



Biosecurity policy and legislation for the global
aquaculture industry

Iona Campbell¹  • Cicilia S. B. Kambey² • Jonalyn P. Mateo³ • Sadock
Flower E. Msuya⁴ • Grant D. Stentiford^{5,6} • Elizabeth J. Cottier-Cook¹



Summary

Aquaculture is part of the food system

Hence, **sustainability** must be considered relative to other sectors comprising the system

A **One Health** approach can be 'designed in' to food sectors/systems (incl. aquaculture)

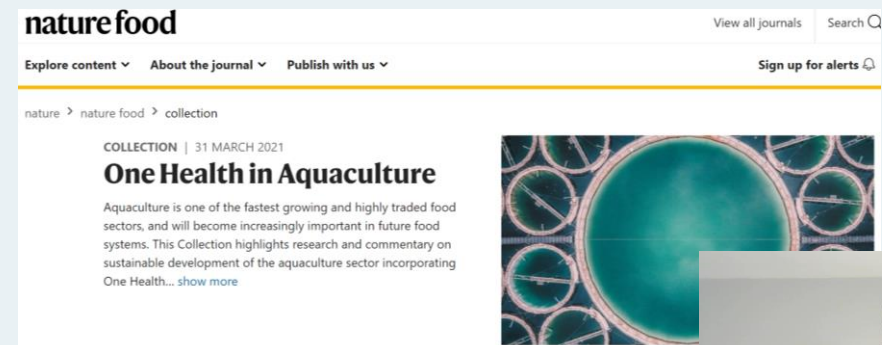
Wider **science-policy expertise** needed across organism/environment/human health outcomes

Enhanced role for national government is implied – farming in national waters

Environmental protection integral to **enabling** safe/sustainable food from aquaculture

Read more about One Health Aquaculture:

<https://www.nature.com/collections/jbbahhegac/>



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Molluscs Sanitation

SUSTAINABLE AQUACULTURE FUTURES



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