

Wallenberg Professor no. 4 Barry Costa-Pierce

Tropical Aquaculture

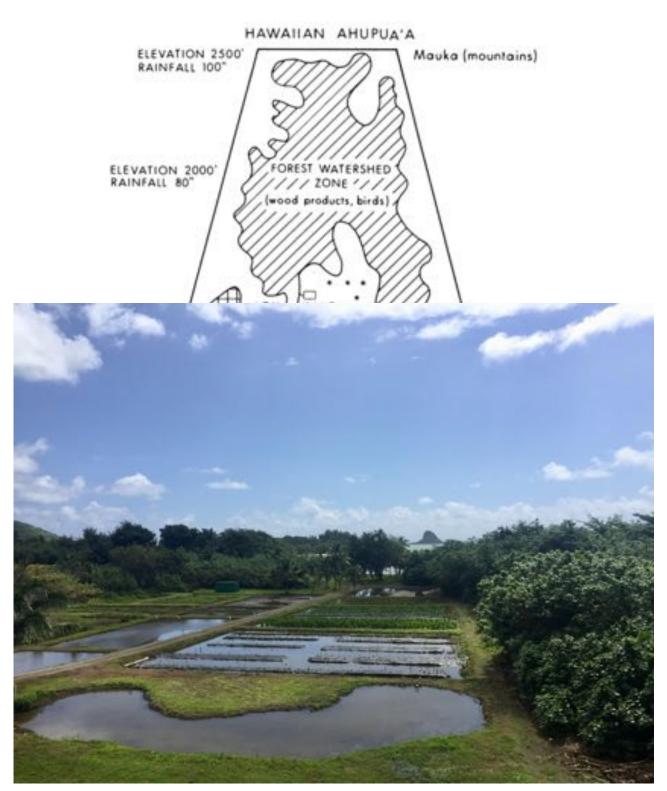
Systems perspective

Integrated farming/aquaculture

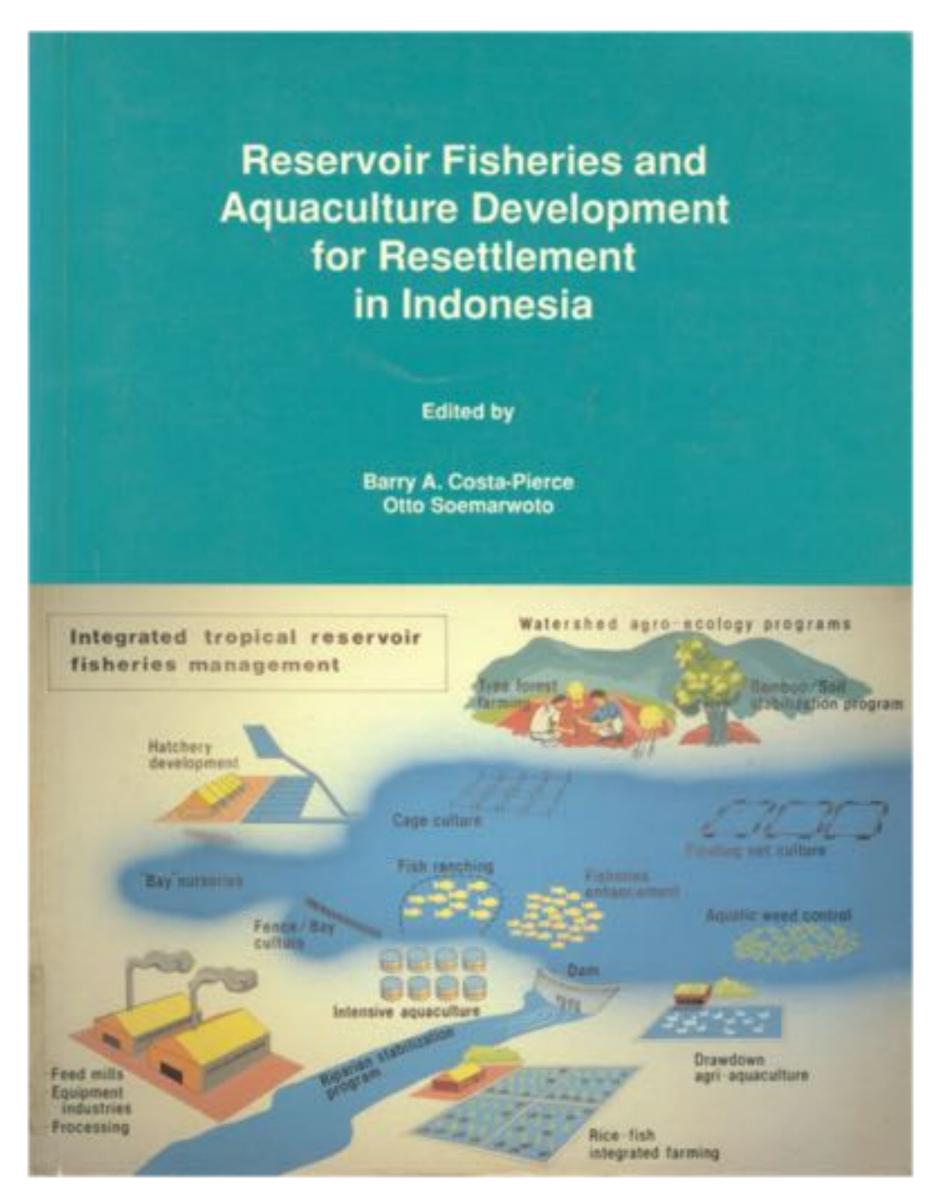
Aquaculture in Ancient Hawaii

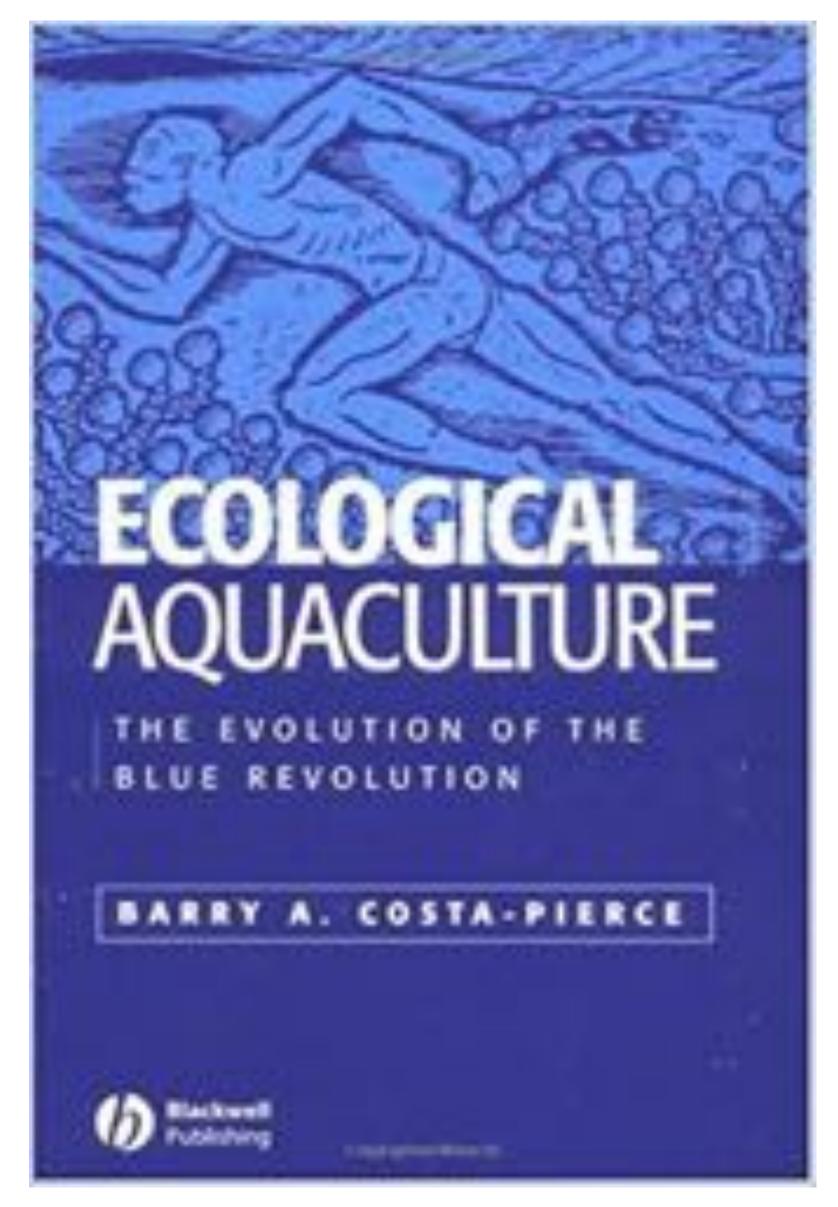
Integrated farming systems included massive freshwater and seawater fish ponds

Barry A. Costa-Pierce



BioScience





Advances in Water Resources 110 (2017) 505-514



Contents lists available at ScienceDirect

Advances in Water Resources



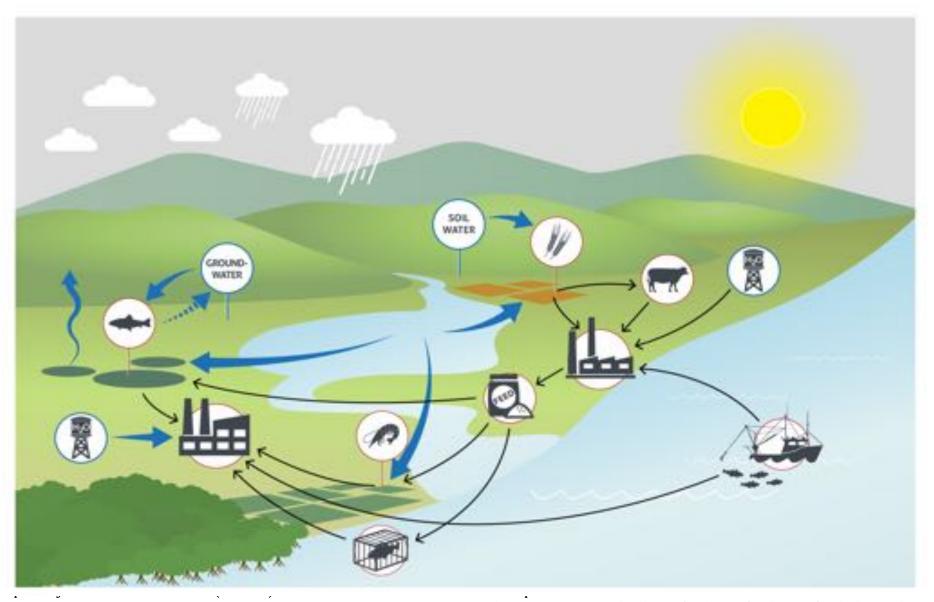


The 'seafood gap' in the food-water nexus literature—issues surrounding freshwater use in seafood production chains



Jessica A. Gephart^{a,*}, Max Troell^{b,c}, Patrik J.G. Henriksson^{b,d}, Malcolm C.M. Beveridge^e, Marc Verdegem^f, Marc Metian^g, Lara D. Mateos^b, Lisa Deutsch^b

- ^a National Socio-Environmental Synthesis Center, University of Maryland, Annapolis, MD, United States
- ^b Stockholm Resilience Centre, Kräftriket 2B, 114 19, Stockholm, Sweden
- ^c Beijer Institute, Royal Swedish Academy of Sciences, P.O. Box 50005, SE-104 05, Stockholm, Sweden
- ^d WorldFish, Jalan Batu Maung, 11960 Penang, Malaysia
- ^e FAO, Via delle Terme di Caracalla, 00153 Rome, Italy
- ^f Wageningen University, Animal Sciences, 6700AH Wageningen, the Netherlands
- g International Atomic Energy Agency, Environment Laboratories, 4a, Quai Antoine Ier, MC-98000, Monaco



^{*} Corresponding author.

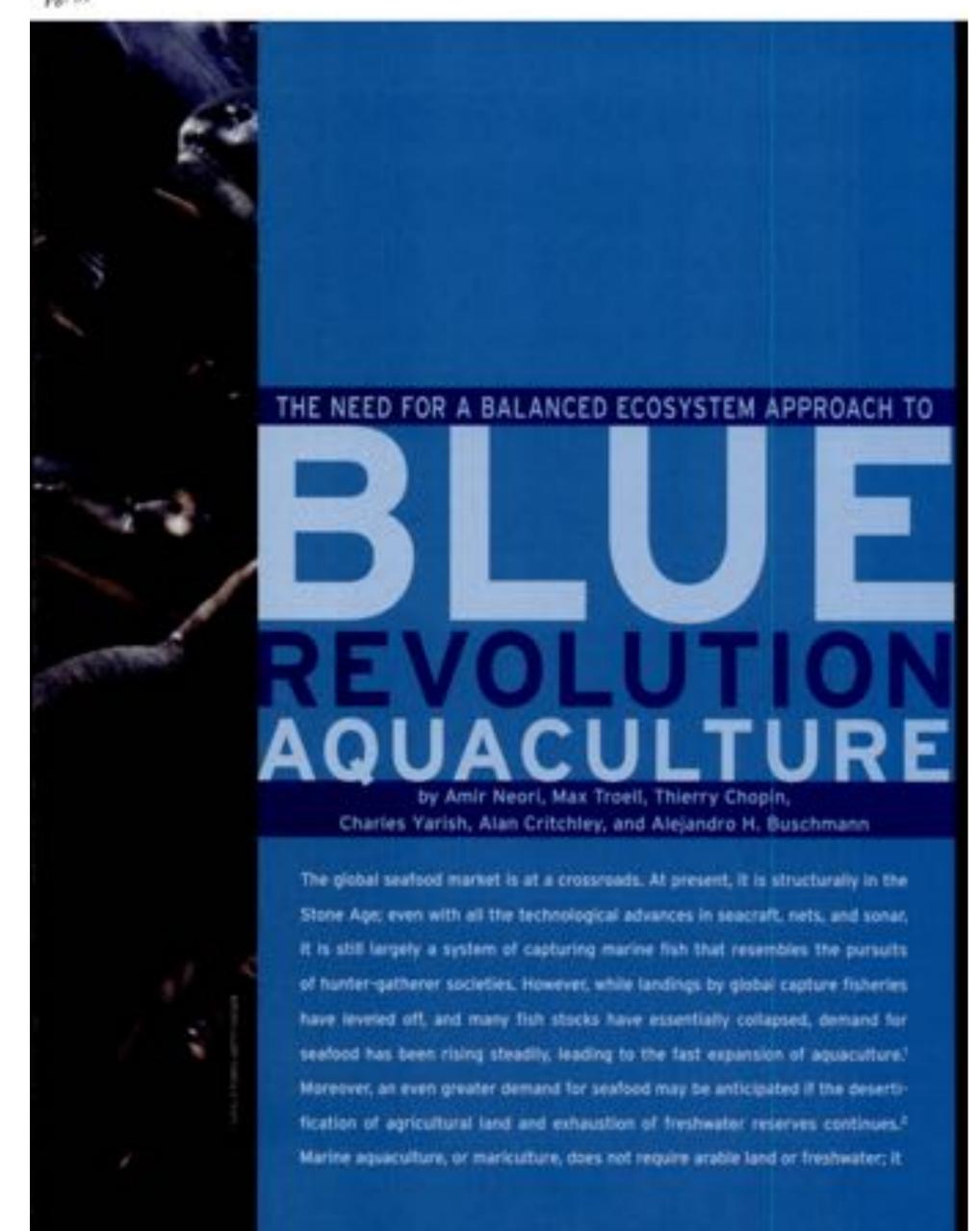
other aquatic animals (henceforth 'seafood'), seafood demand is projected to increase with growing populations and demographic shifts (Delgado et al., 2003; Tilman et al., 2011; FAO, 2016a). Since

http://dx.doi.org/10.1016/j.advwatres.2017.03.025

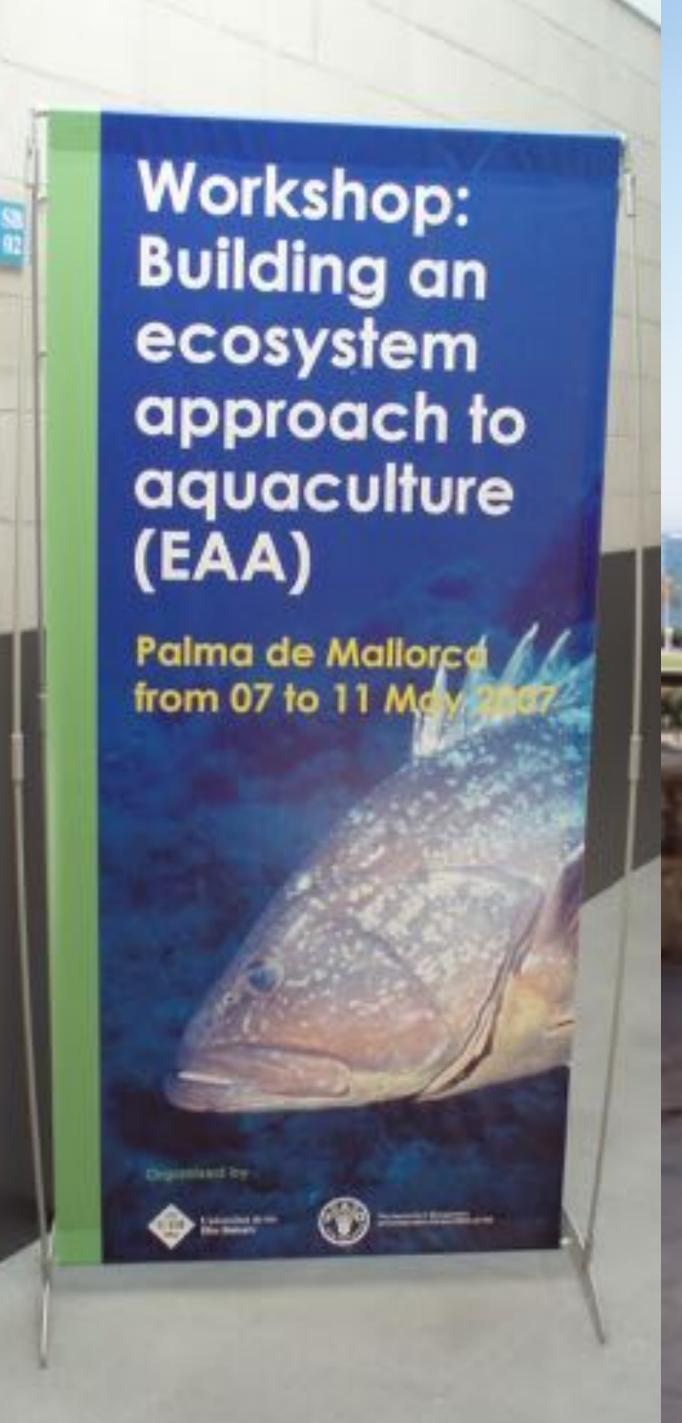
0309-1708/© 2017 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license. (http://creativecommons.org/licenses/by-nc-nd/4.0/)

THE NEED FOR A BALANCED ECOSYSTEM APPROACH TO BLUE REVOLUTION AQUACU. Amir Neori; Max Troell; Thierry Chopin; Charles Yarish; et al

Environment: Apr 2007; 49, 3; Research Library Core



E-mail address: jgephart@sesync.org (J.A. Gephart).





Building on

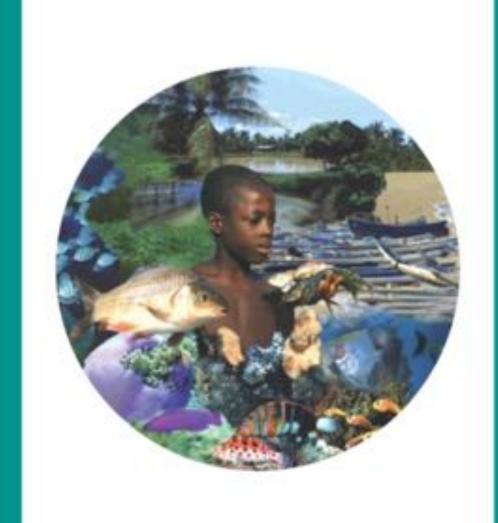
- UN Convention on the Law of the Sea (1982);
- FAO Code of Conduct for Responsible Fisheries (1995);
- Convention on Biological Diversity (CBD) (1992).

2003

The ecosystem approach to fisheries

Issues, terminology, principles, institutional foundations, implementation and outlook

FAO FISHERIES TECHNICAL PAPER

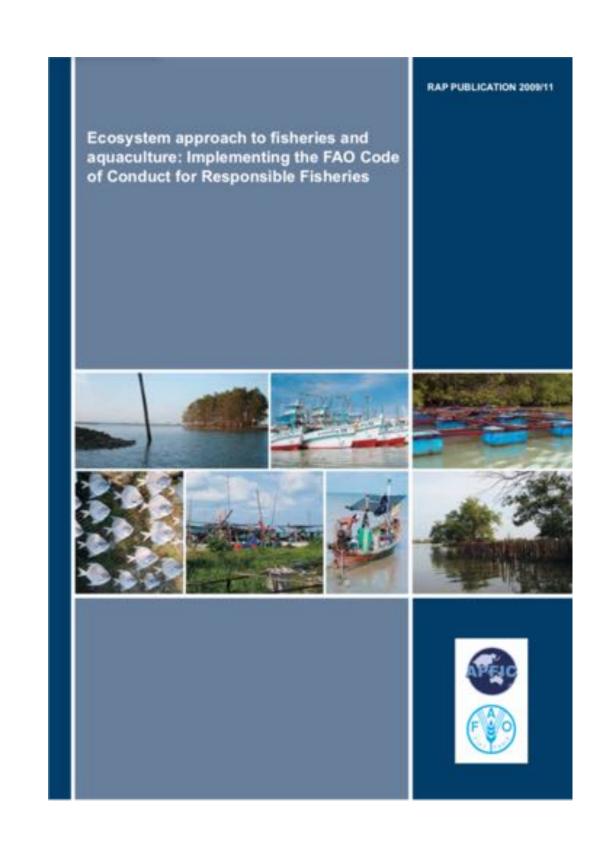


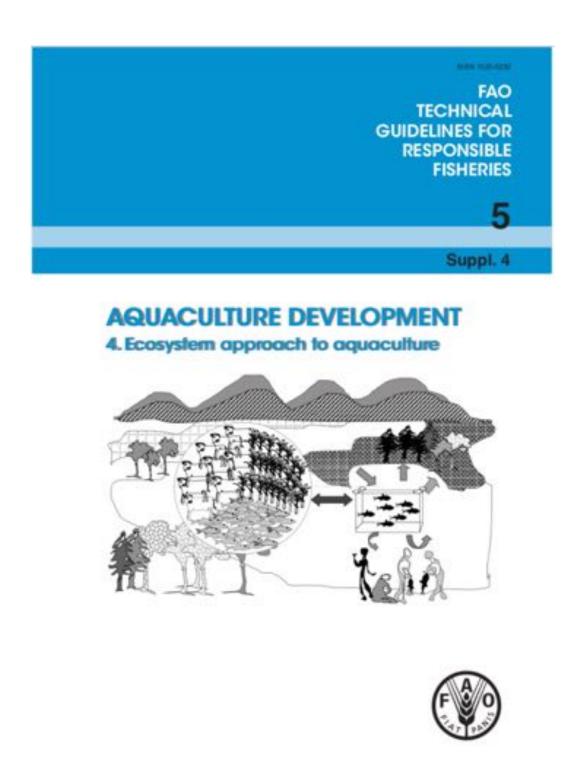


Ecosystem Approach to Aquaculture

2007 2009 2011



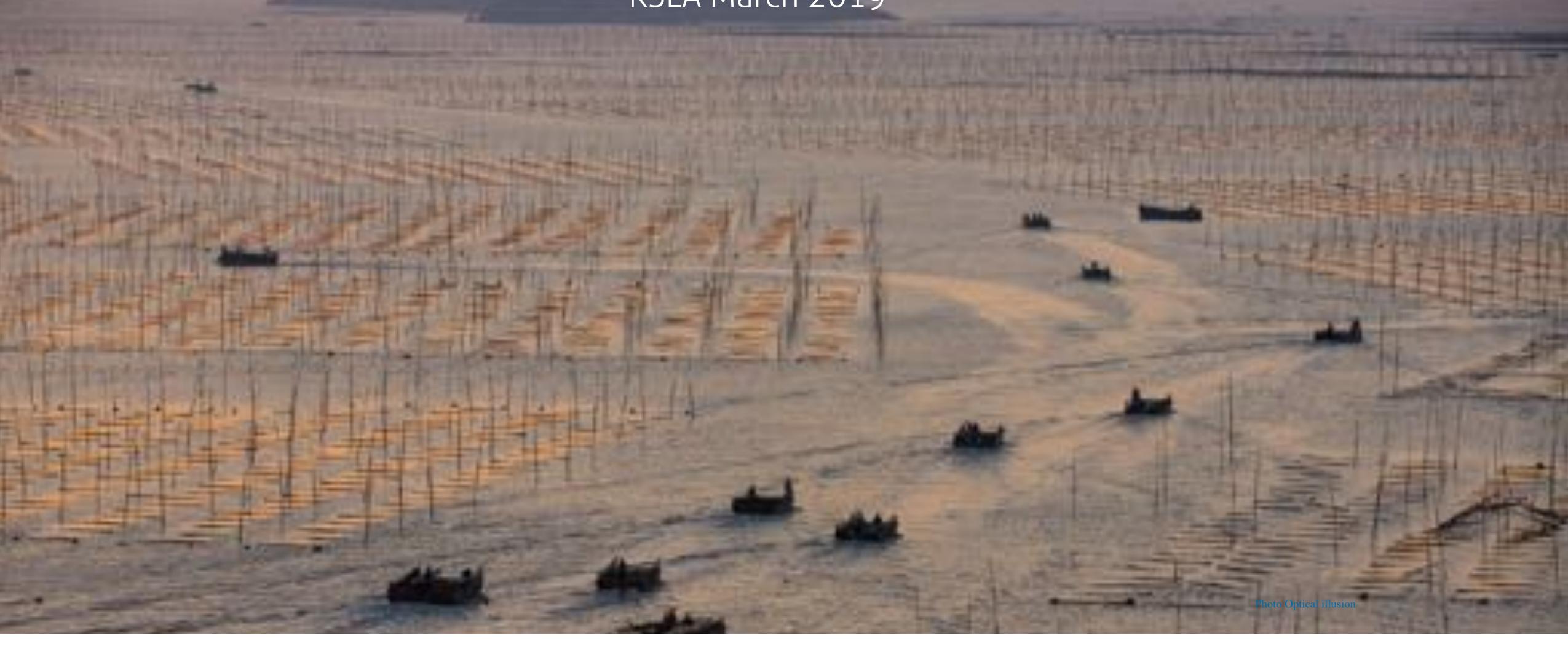




"A strategy for the integration of the activity within the wider ecosystem such that it promotes sustainable development and resilience of interlinked social-ecological systems"

Perspectives on sustainable aquaculture

KSLA March 2019









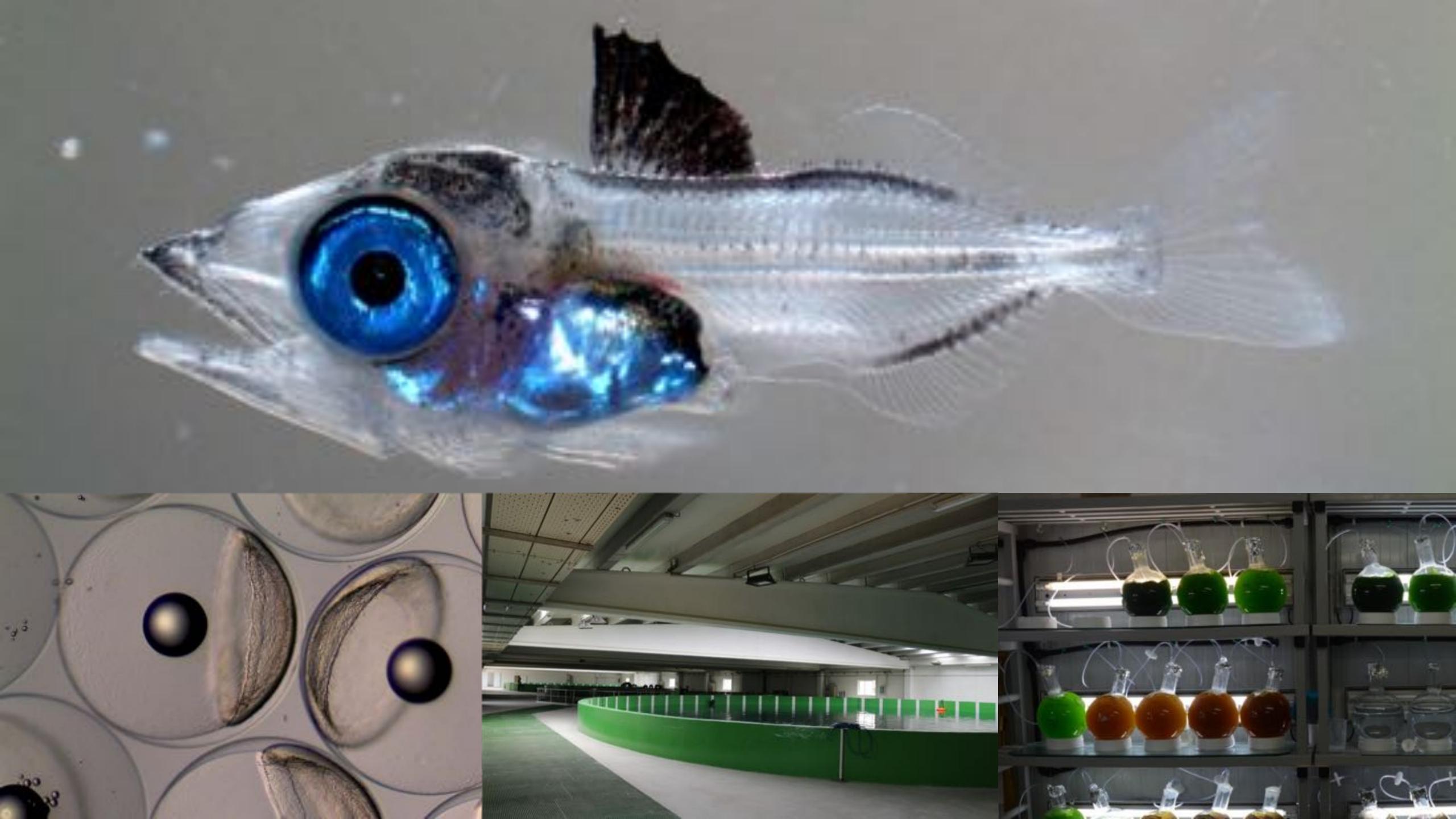


Program Aquaculture and Sustainable Seafood



WorldFish center, Malaysia; Leiden University, The Netherlands; International Atomic Energy Agency, Monaco; Uppsala University, Sweden; Swedish Institute for Food and Biotechnology (SIK), Sweden; University of British Colombia, Canada; Stanford University, USA; Stockholm Environment Institute, University of York, UK; Dalhousie University, Canada; University of Wollongong, Australia; University of New Brunswick, Canada; Bangladesh Agricultural University, Bangladesh; Western Indian Ocean Marine Science Association (WIOMSA), Tanzania; Dar es Salaam University, Tanzania; Kenya Marine and Fisheries Research Institute (KMFRI), Kenya; i-mar, Universidad de Los Lagos, Chile; Israel Oceanographic and Limnological Research Ltd., Israel; Stirling University, Scotland; Shanghai Ocean University, China; Department of Physical Geography and Quaternary Geology, Stockholm University, Sweden; Institute for Marine Science, Tanzania; Gothenburg University, Sweden; Department of Fisheries (DoF), Yangon, Myanmar; Umeå University, Sweden; An Giang University, Vietnam; University of Virginia, USA; Nofima AS, Norway; University of Haifa, Israel; Newcastle University, UK; Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Germany; University Santiago de Compostela, Spain







Annu. Rev. Environ. Resour. 2005. 30:185-218 doi: 10.1146/annurev.energy.30.081804.121034 Copyright © 2005 by Annual Reviews. All rights reserved First published online as a Review in Advance on June 14, 2005

AQUACULTURE AND OCEAN RESOURCES: Raising Tigers of the Sea

Rosamond Naylor¹ and Marshall Burke²

Julie Wrigley Senior Fellow¹ and Research Fellow,² Center for Environmental Science and Policy, Stanford University, Stanford, California 94305; email: roz@stanford.edu, mburke@stanford.edu

Key Words marine aquaculture, fish meal, ecological impacts, offshore aquaculture

■ Abstract With continued human pressure on marine fisheries and ocean resources, aquaculture has become one of the most promising avenues for increasing marine fish production in the future. This review presents recent trends and future prospects for the aquaculture industry, with particular attention paid to ocean farming and carnivorous finfish species. The benefits of farming carnivorous fish have been challenged; extensive research on salmon has shown that farming such fish can have negative ecological, social, and health impacts on areas and parties vastly separated in space. Similar research is only beginning for the new carnivorous species farmed or ranched in marine environments, such as cod, halibut, and bluefin tuna. These fish have

"Farming the Tigers".....!



University of Connecticut DigitalCommons@UConn

Publications

Department of Ecology & Evolutionary Biology -Stamford

4-1-2008

MARINE SCIENCE ASSESSMENT OF CAPTURE-BASED TUNA (Thunnus orientalis) AQUACULTURE IN THE ENSENADA REGION OF NORTHERN BAJA CALIFORNIA, MEXICO

José A. Zertuche-González Universidad Autonoma de Baja California Ensenada

Oscar Sosa-Nishizaki
Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE)

Juan G. Vaca Rodriguez Universidad Autonoma de Baja California Ensenada

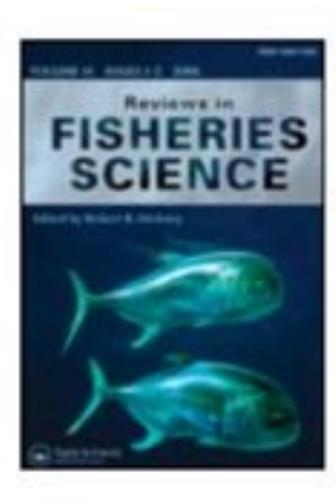
Raul del Moral Simanek
Consejo Nacional de Ciencia y Tecnologia (CONACyT) Ensenada

Charles Yarish
University of Connecticut, charles.yarish@uconn.edu

Recommended Citation

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Reviews in Fisheries Science & Aquaculture

Publication details, including instructions for authors and subscription information: http://www.tandfonline.com/loi/brfs21

Farming of Bluefin Tuna-Reconsidering Global Estimates and Sustainability Concerns

Marc Metian^a, Simon Pouil^a, André Boustany^b & Max Troell^{ac}

Stockholm Resilience Center, Stockholm University, Stockholm, Sweden

b Marine Geospatial Ecology Lab, Duke University, Beaufort, North Carolina, USA

⁶ Beijer Institute of Ecological Economics, Stockholm, Sweden Published online: 27 Jun 2014.

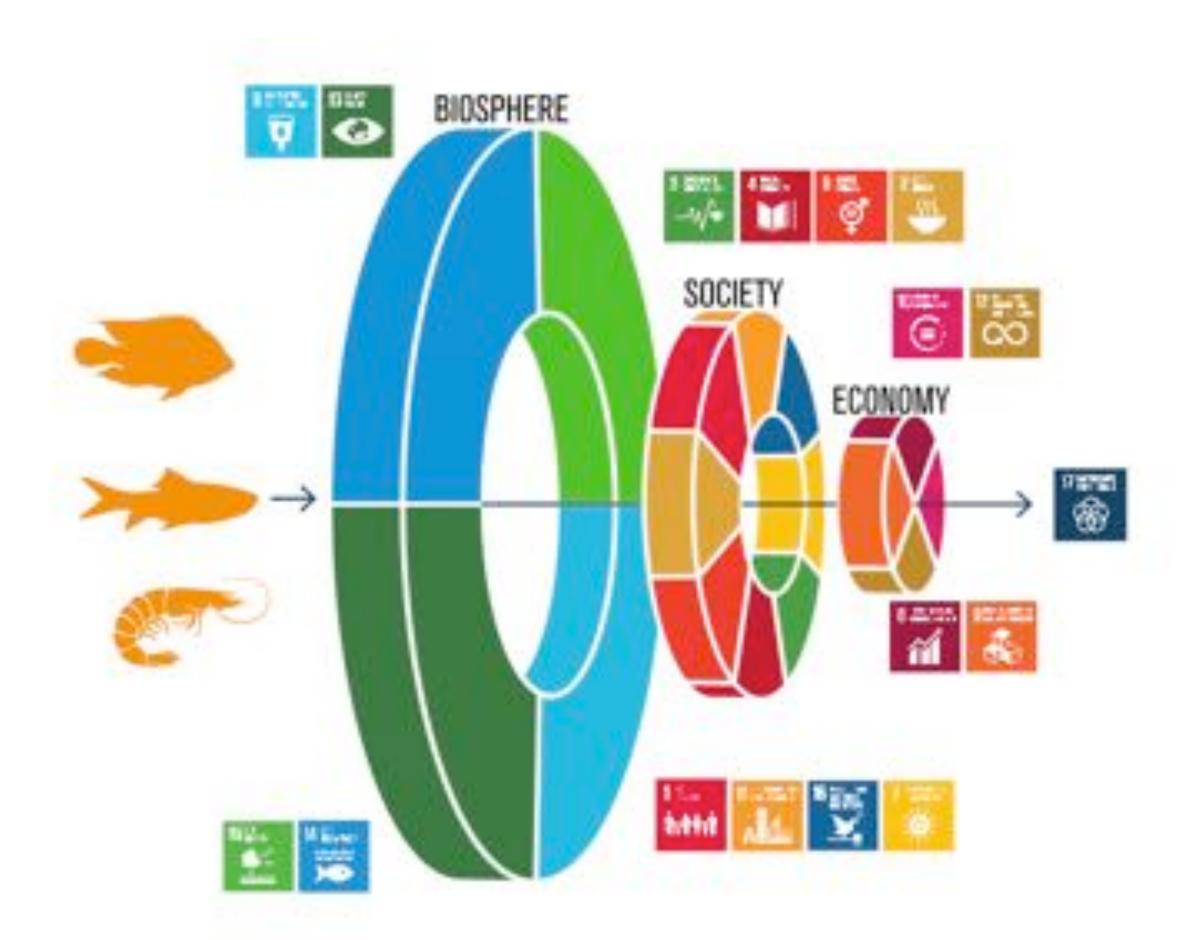
We can farm....anything...
....and anywhere

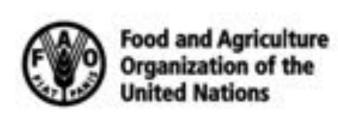
but....

The question is if we should!

What species and systems should form the future? ...how do we know?

Seafood Sustainability



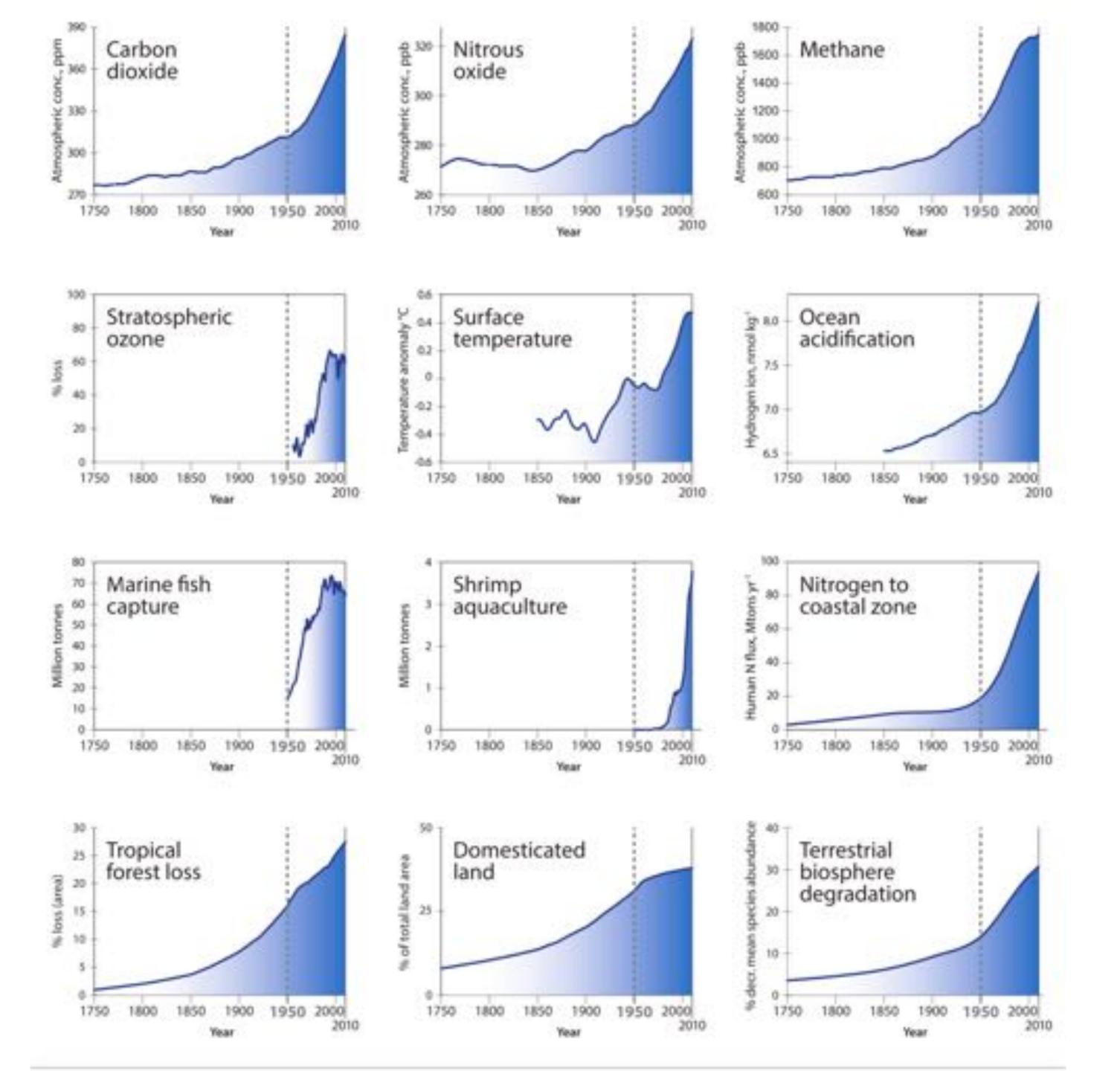


FIAA/C1141 (En)
FAO
Fisheries and
Aquaculture Circular

THE 2030 AGENDA AND THE SDGS: THE CHALLENGE FOR AQUACULTURE DEVELOPMENT AND MANAGEMENT



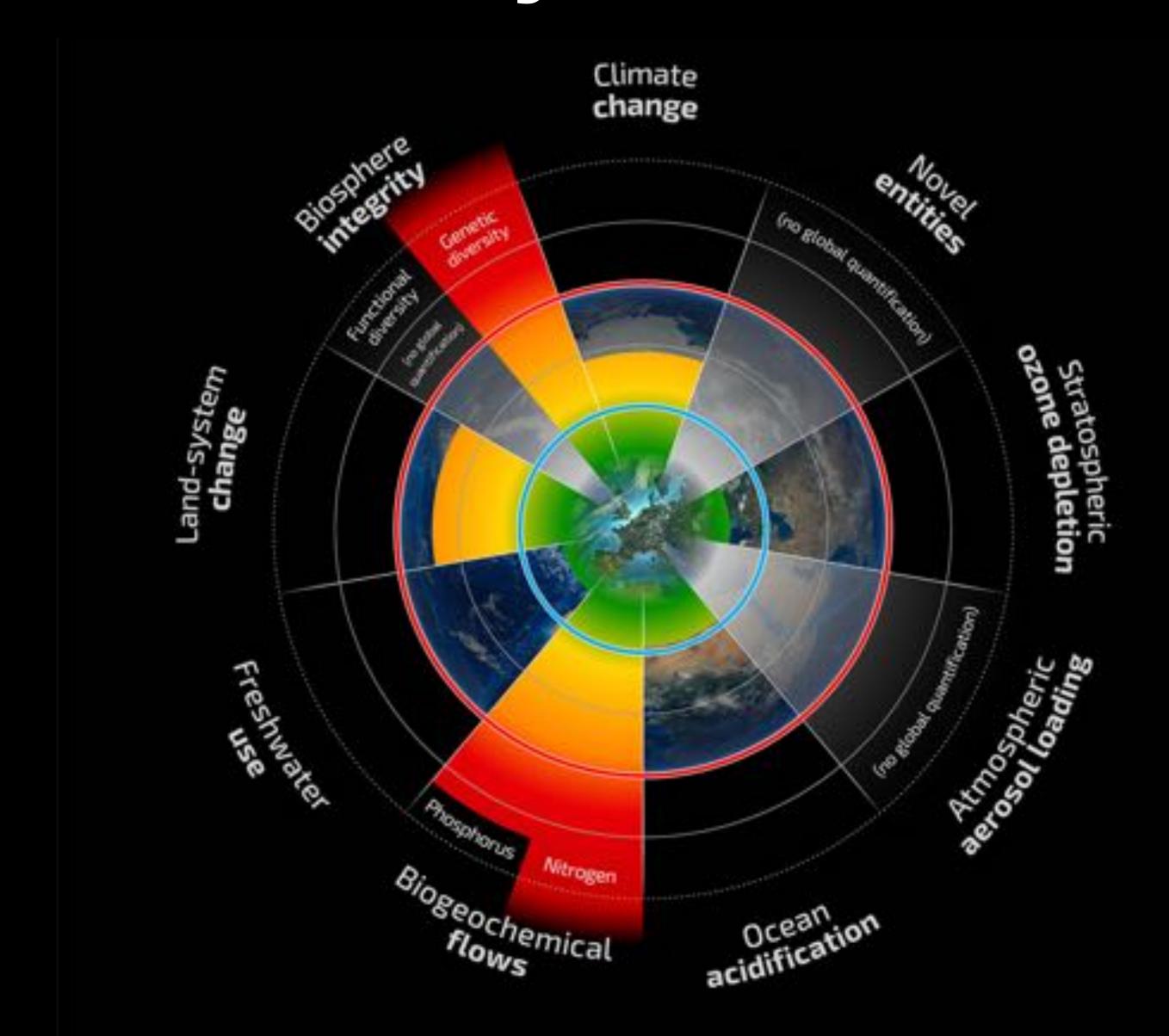
Why is seafood and particularly aquaculture important for the future food portfolio?



The BIG acceleration - 1950 to today

"Small world on a big planet to a big world on a small planet"

Planetary Boundaries

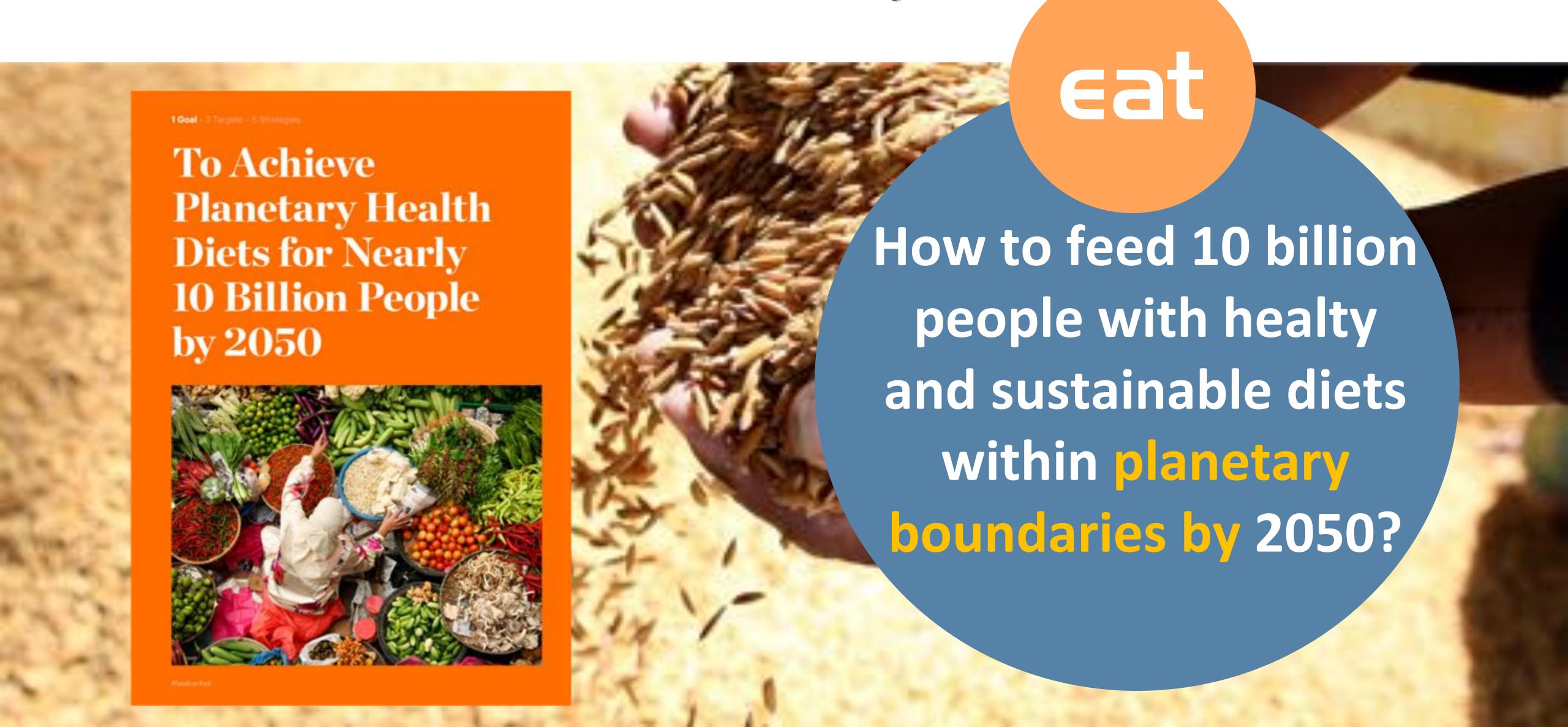


The role of food

- GHG 25%
- Landtransformation 75%
- Biological diversity loss 75-80%
- Nitrogen and Phosphorous 100%

• Freshwater 70%

EAT-Lancet Commission on healthy diets from Sustainable Food Systems"



Scientific Targets for Healthy Diets

Human boundaries for:

- Whole grains
 Vegetables
- 3) Fruits
- 4) Proteins
- 5) Dairy 6) Added Fat

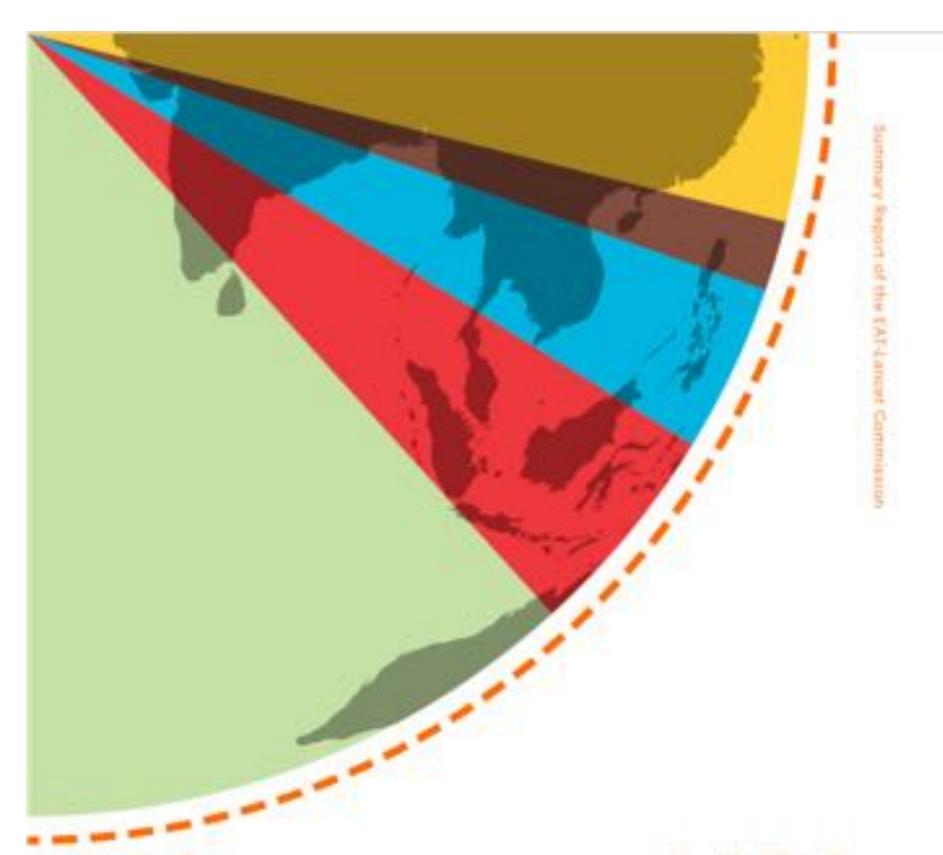


Scientific Targets for Sustainable Food Systems



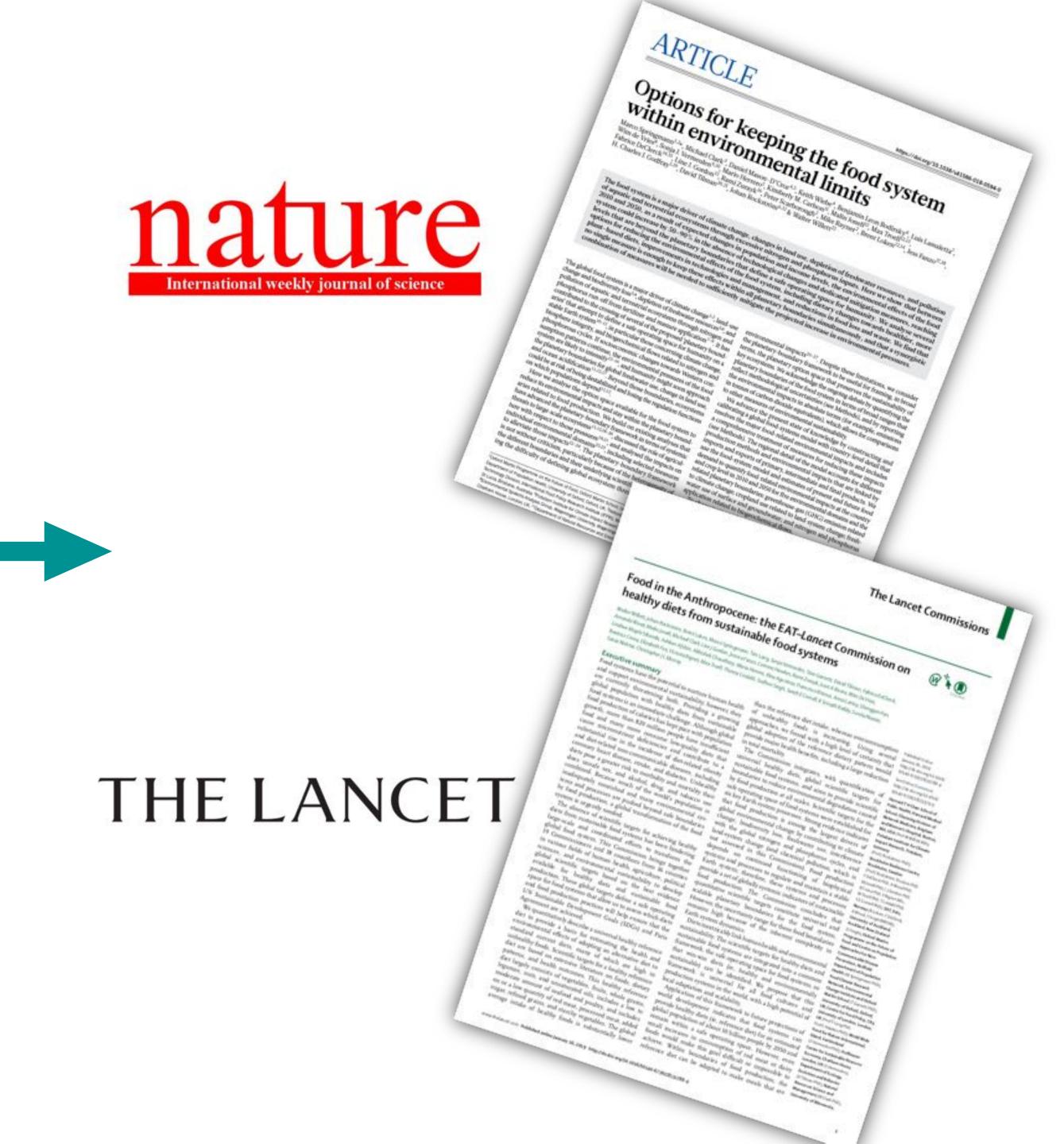
Planetary boundaries for:

- 1) GHG emissions
- 2) Water used
- 3) Nitrogen flows
- 4) Phosphorus flows 5) Biodiversity lost
- 6) Land converted



Healthy Diets From Sustainable Food Systems

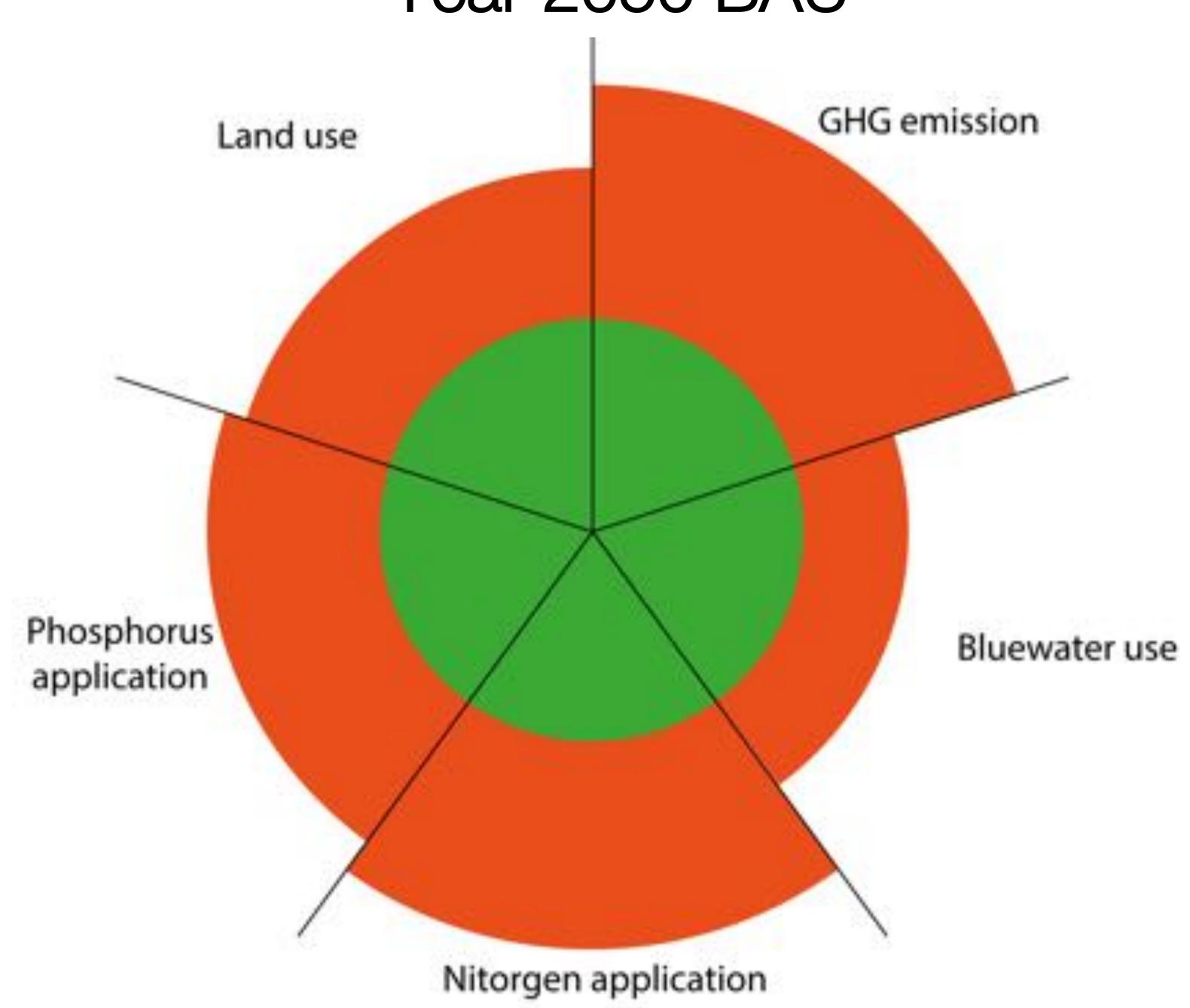
Food Planet Health







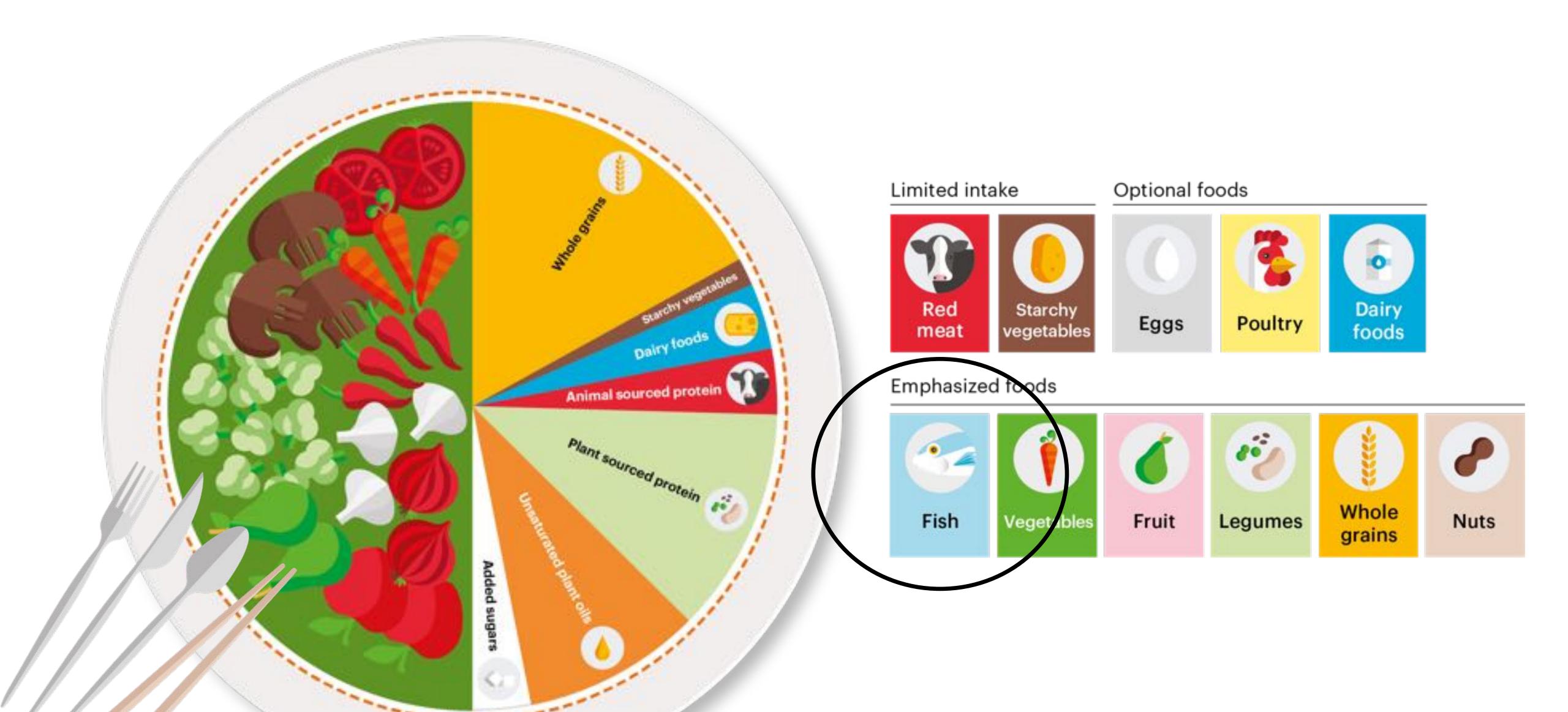
Year 2050 BAU



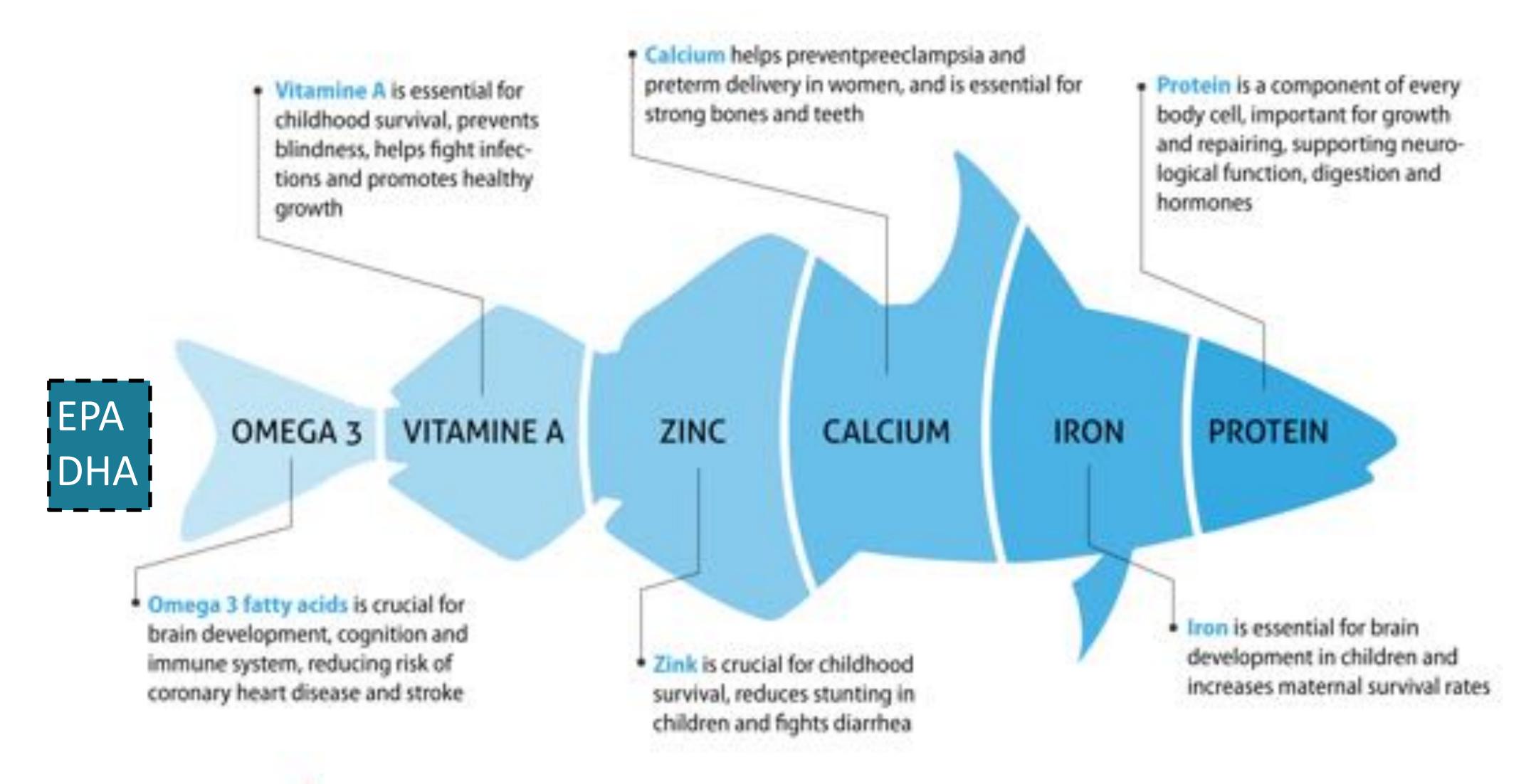
Sce	NOK	

narios		GHG emissions	Cropland	Water use	Nitrogen application	Phosphorus application	Biodiversity loss	
Food production boundary			5.0 (4.7-5.4) 5.2	13 (11.0-15.0) 12.6	2.5 (1.0-4.0) 1.8	90 (65.0-140.0) 131.8	8 (6.0-16.0)	10 (1-80) 100-1000
Baseline in 2010								
Production (2050)	Waste (2050)	Diet (2050)						
BAU	Full waste	BAU	9.8	21.1	3.0	199.5	27.5	1,043
BAU	Full waste	Dietary shift	5.0	21.1	3.0	191.4	25.5	1,270
BAU	Halve waste	BAU	9.2	18.2	2.6	171.0	23.2	684
BAU	Halve waste	Dietary shift	4.5	18.1	2.6	162.6	21.2	885
PROD	Full waste	BAU	8.9	14.8	2.2	187.3	25.5	206
PROD	Full waste	Dietary shift	4.5	14.8	2.2	179.5	24.1	351
PROD	Halve waste	BAU	8:3	12.7	1.9	160.1	21.5	50
PROD	Halve waste	Dietary shift	4.1	12.7	1.9	151.7	20.0	102
PROD+	Full waste	BAU	8.7	13.1	2.2	147.6	16.5	37
PROD+	Full waste	Dietary shift	4.4	12.8	2.1	140.8	15.4	34
PROD+	Halve waste	BAU	8.1	11.3	1.9	128.2	14.2	21
PROD+	Halve waste	Dietary shift	4.0	11.0	1.9	121.3	13.1	19

Sustainable and health diets



Seafood and nutrition



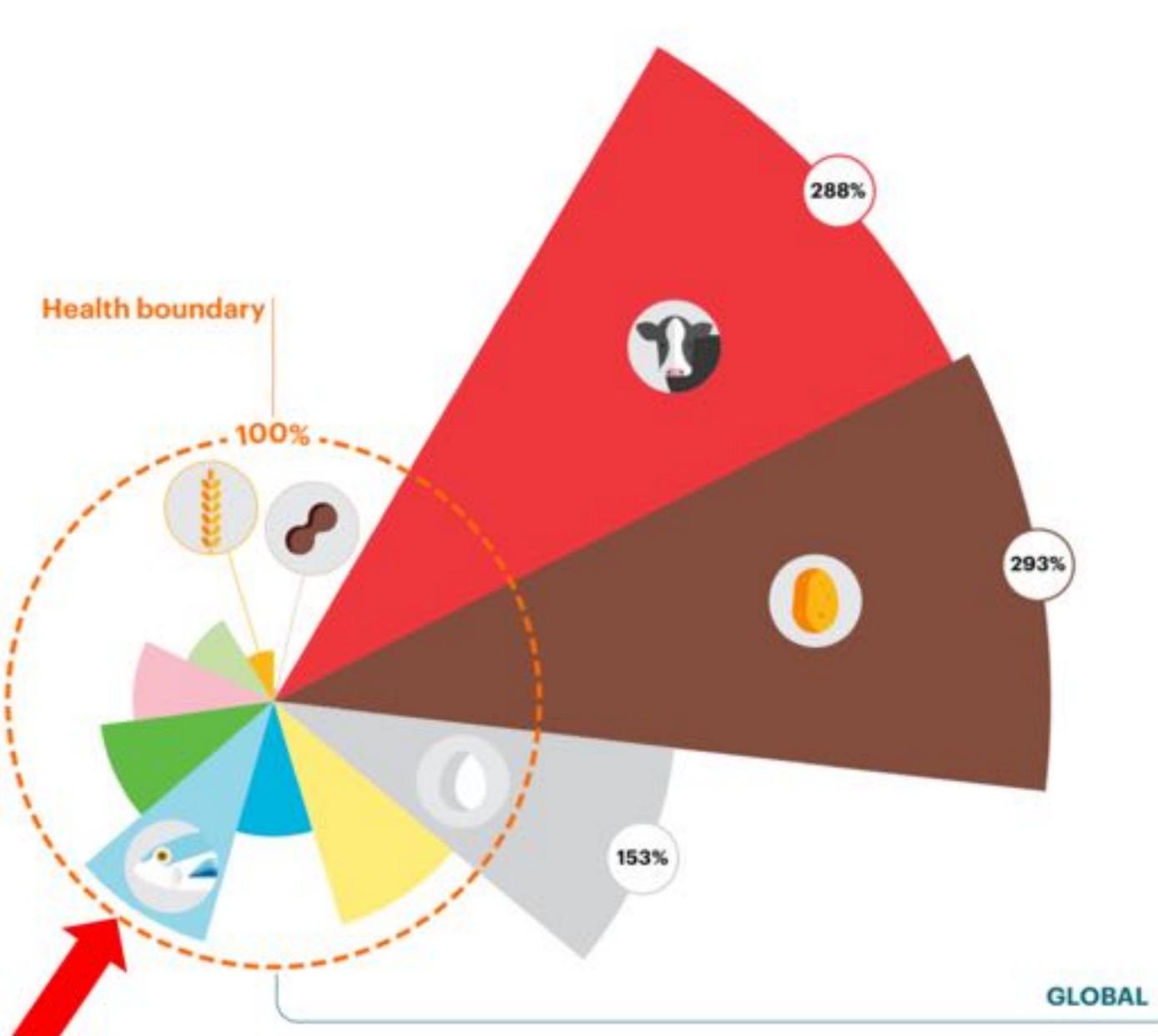
Toxics: some seafood can accumulate heavy metals, dioxine, PCB, ciguatoxin and antibiotic residuals.

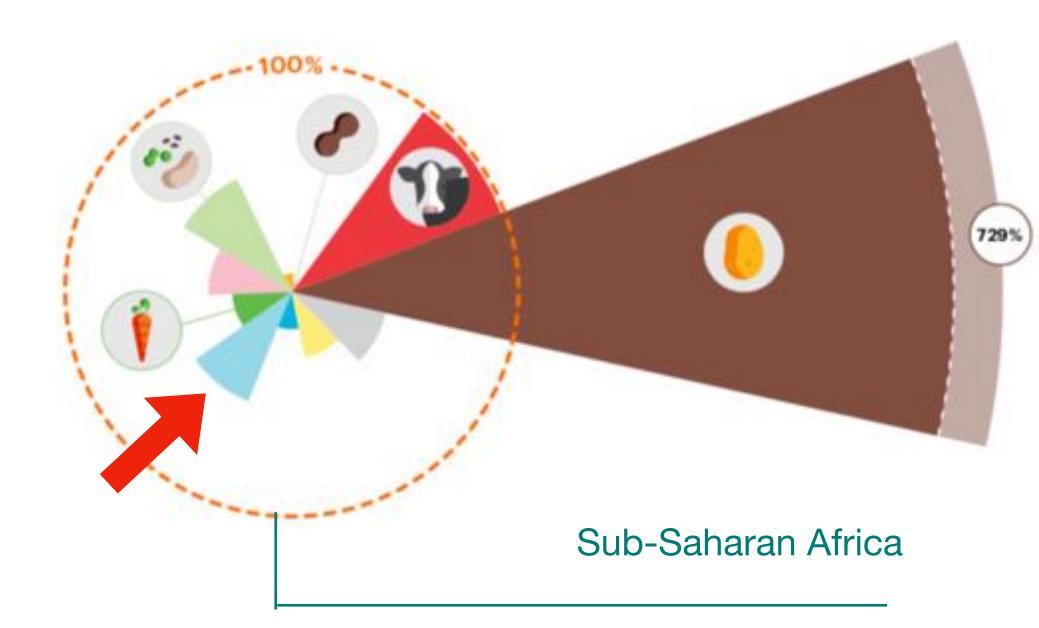
Some more conclusions from the EAT-Lancet work

- Seafood can have a lower environmental footprint compared to other terrestrial animal production but that this differs between species and systems
- Aquacultures use of feeds generate many of the environmental impacts
- We need to double aquaculture production by 2050

Global Konsumtion





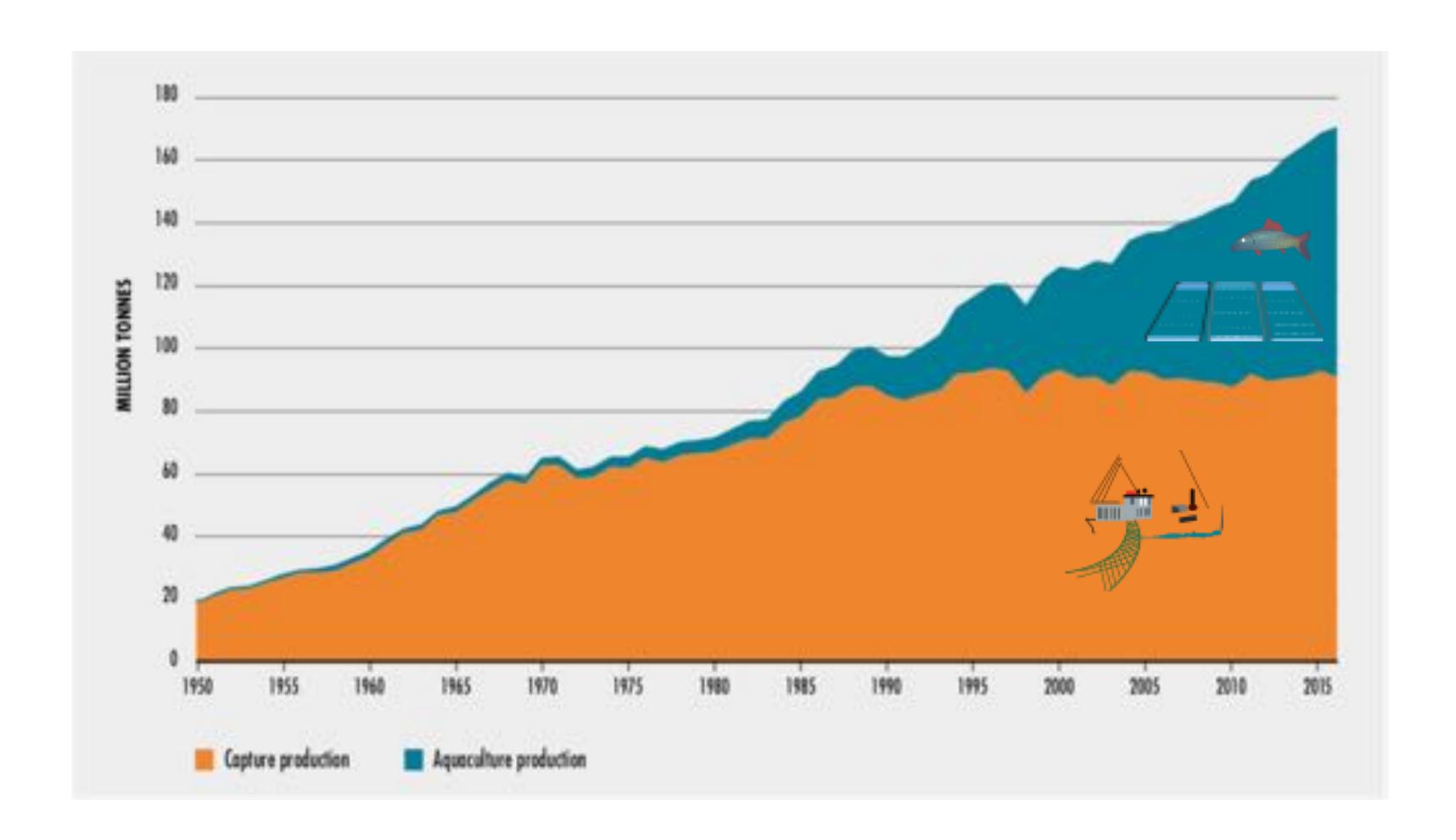




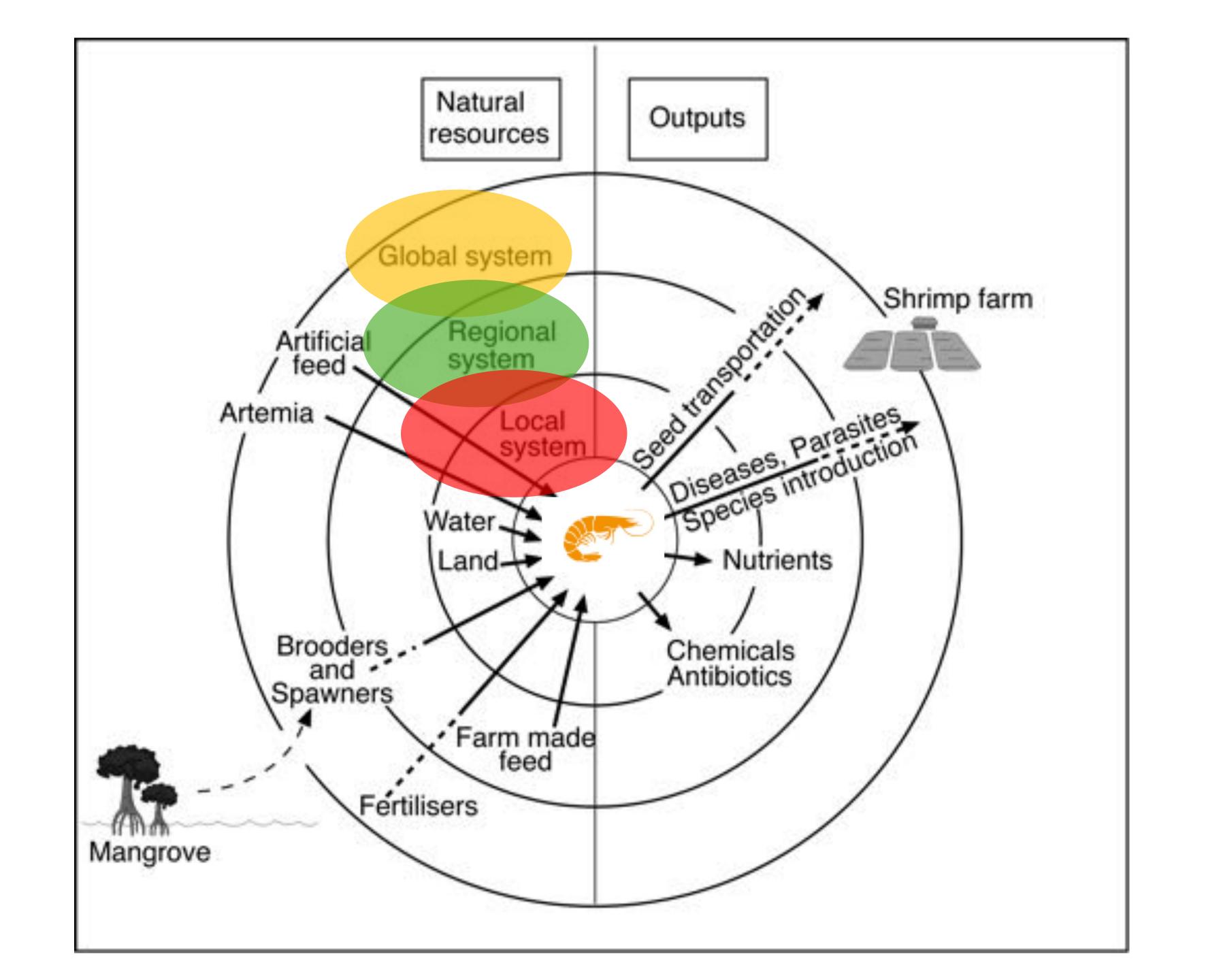
Report

"Increased understanding about seafoods specific role for human health and environmental sustainabilty and identification of future research areas"

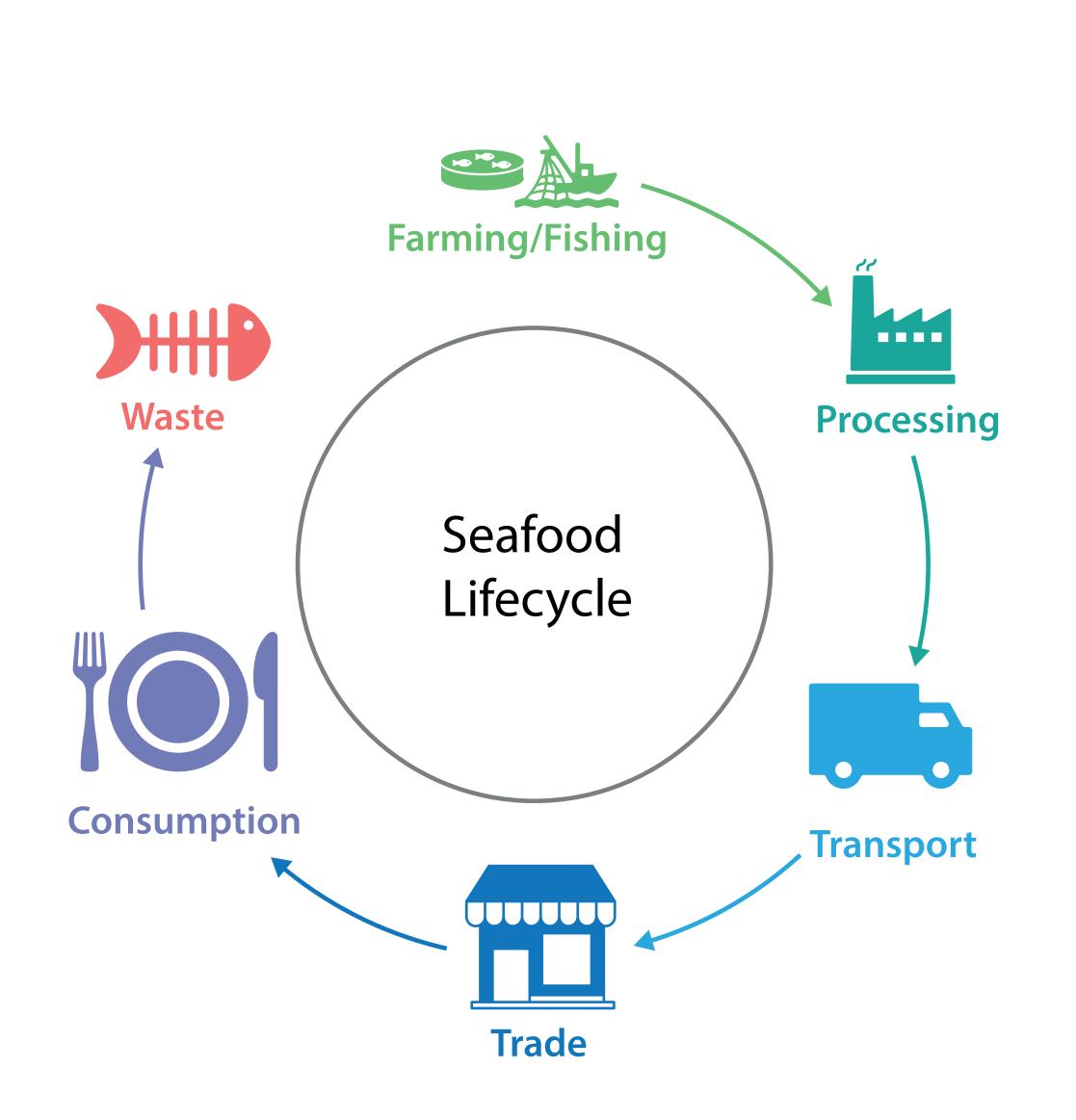
Blue Transformation - What and how?

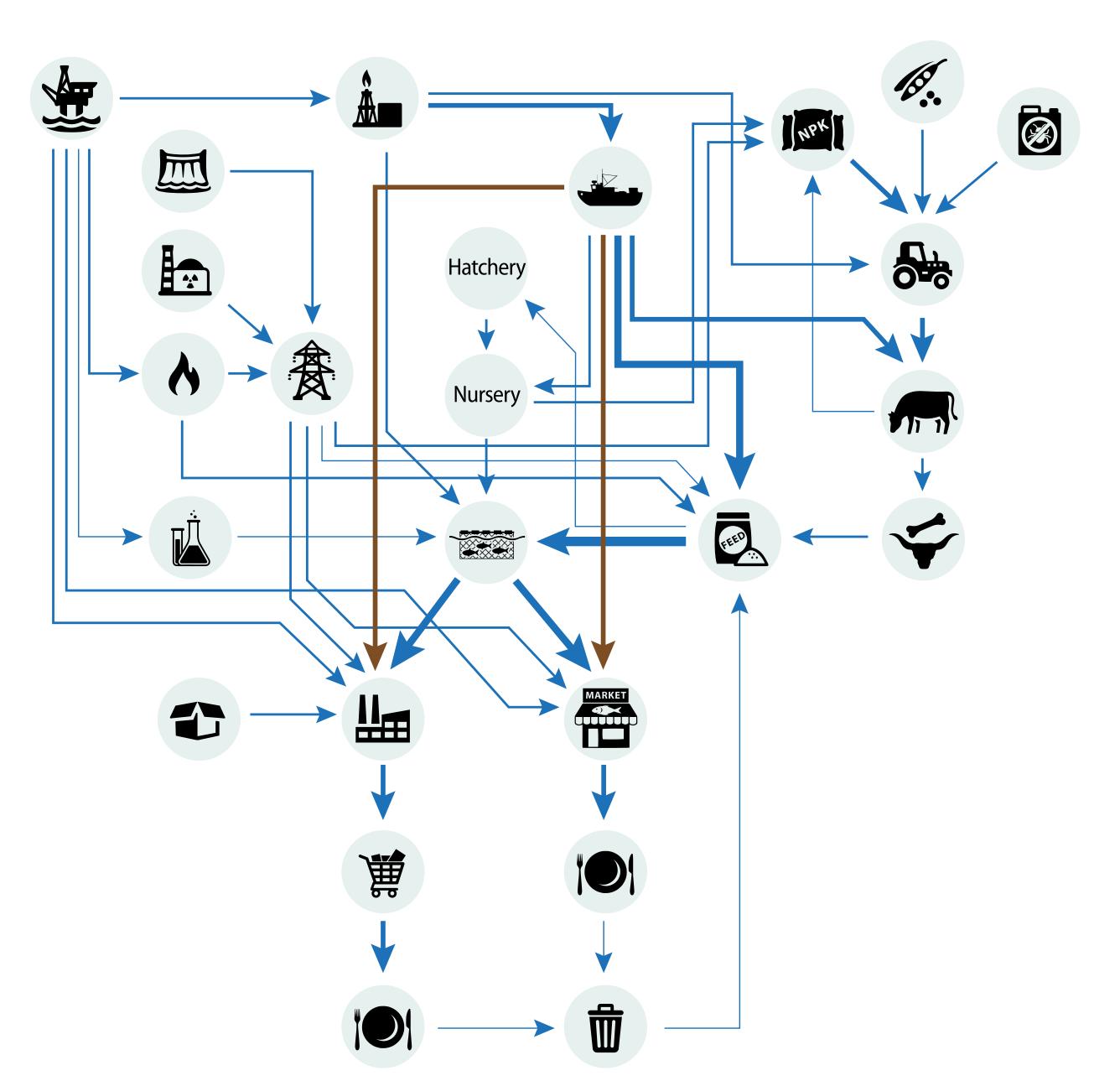


Aquaculture and sustainability Scale and metrics

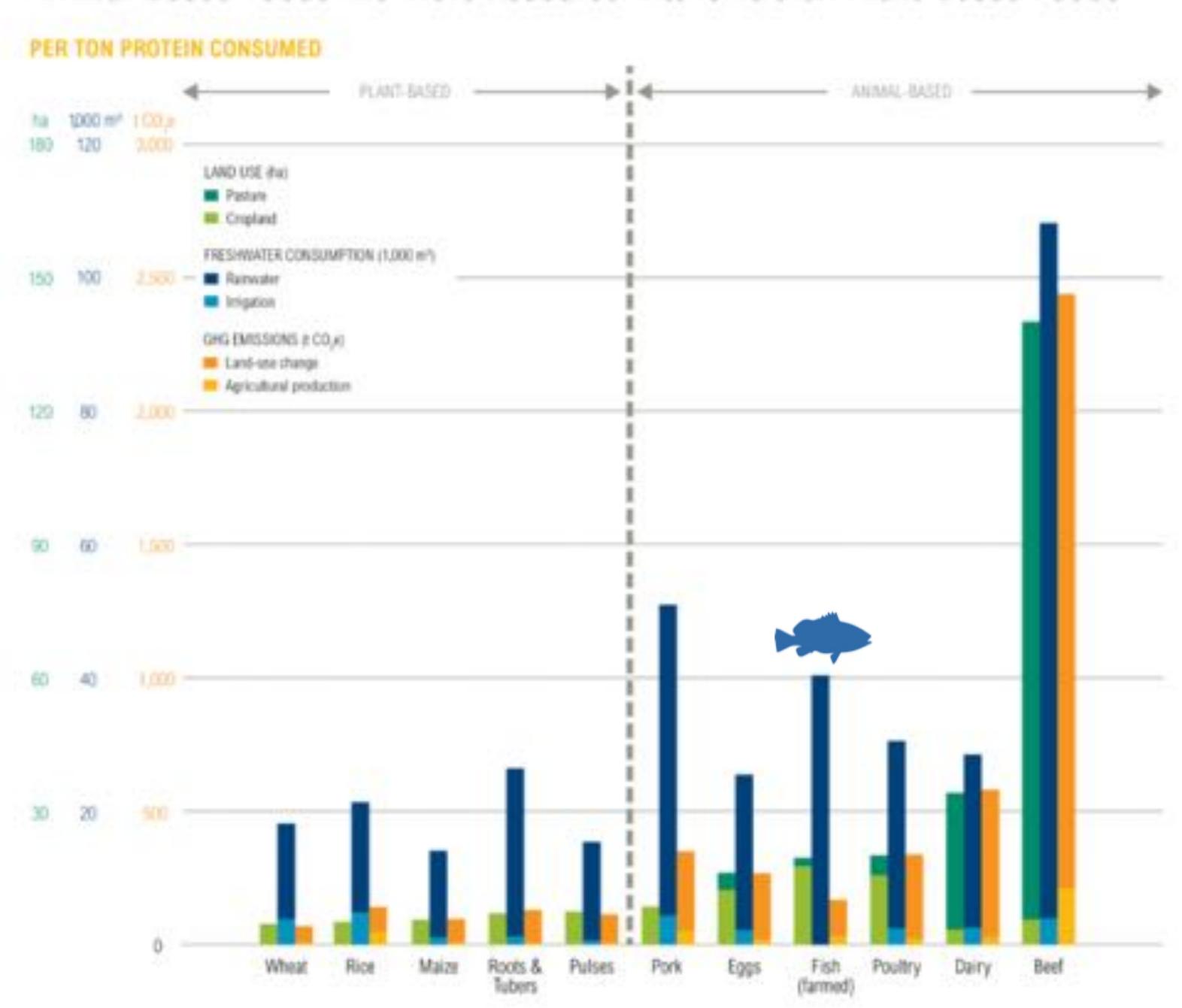


Lifecycle Analysis of Seafood



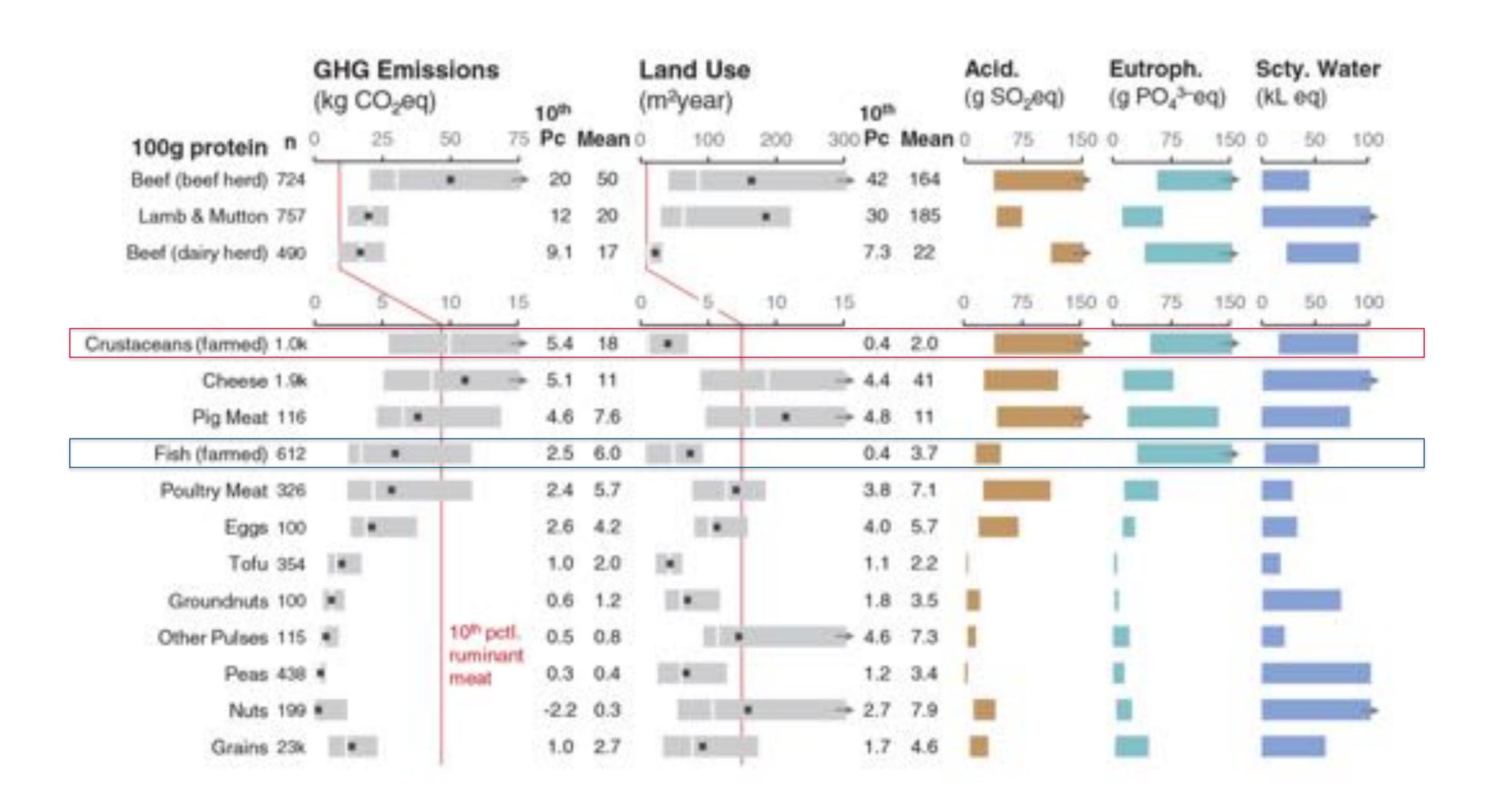


Animal-Based Foods Are More Resource-Intensive than Plant-Based Foods





Aquaculture's role in the future food portfolio



Ref: Poore & Nemecek 2018



Equitable mariculture

A diagnostic framework for equitable mariculture development in the Western Indian Ocean



ACIAR MONOGRAPH 204













Key Principles for equitable aquaculture



Rewarding – economic Economically and financially profitable Beneficial



Rights – access

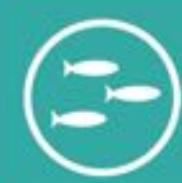
For people and communities

Empowerment

Acesssible and inclusive

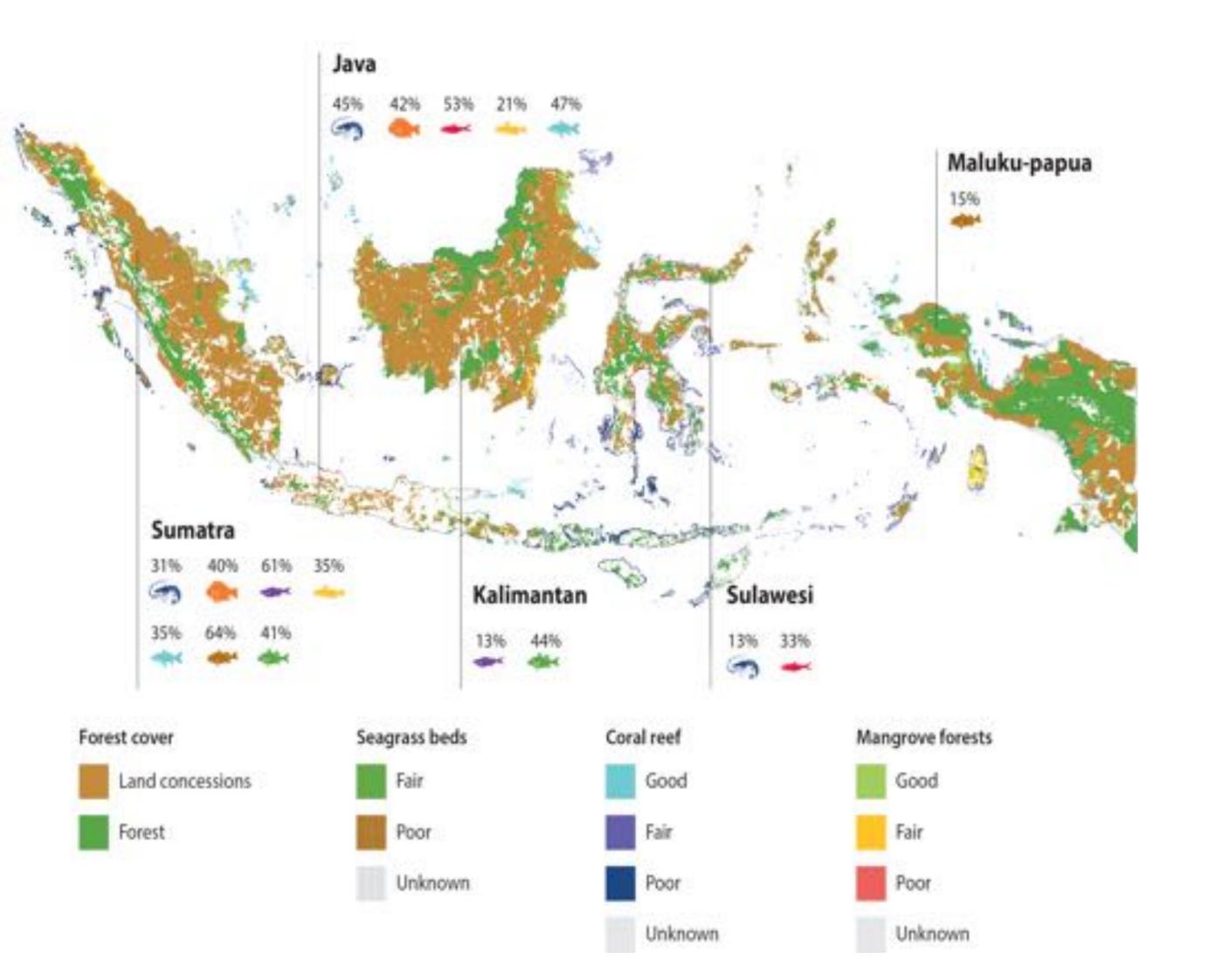


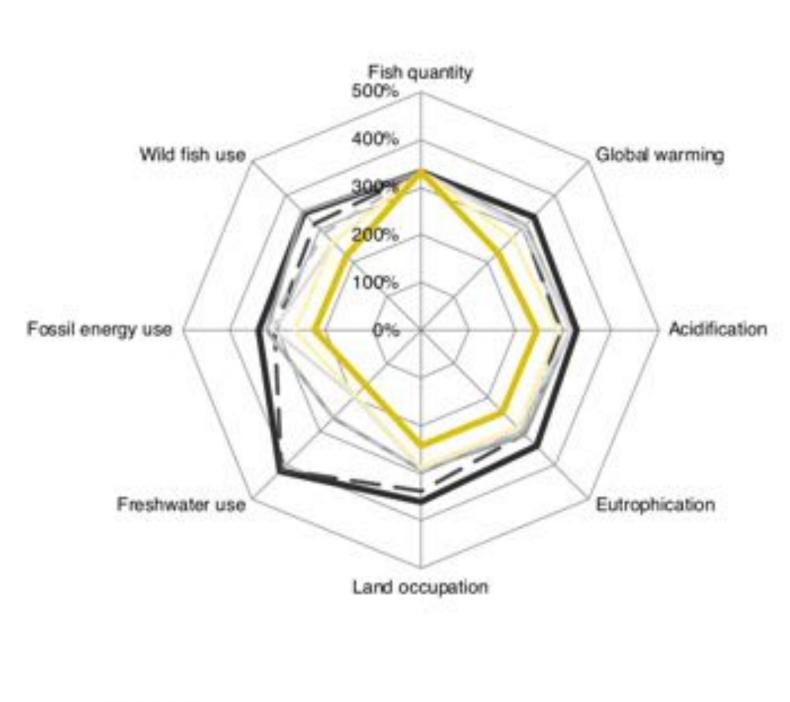
Sustainable – continuity, duration over time Sustainability Intergenerational equity

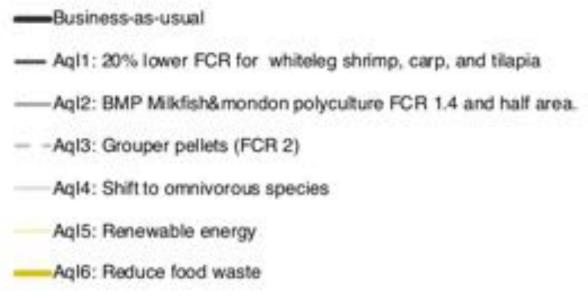


Conservation of the resource base – life support systems Environmentally-friendly and responsible

Indonesian aquaculture





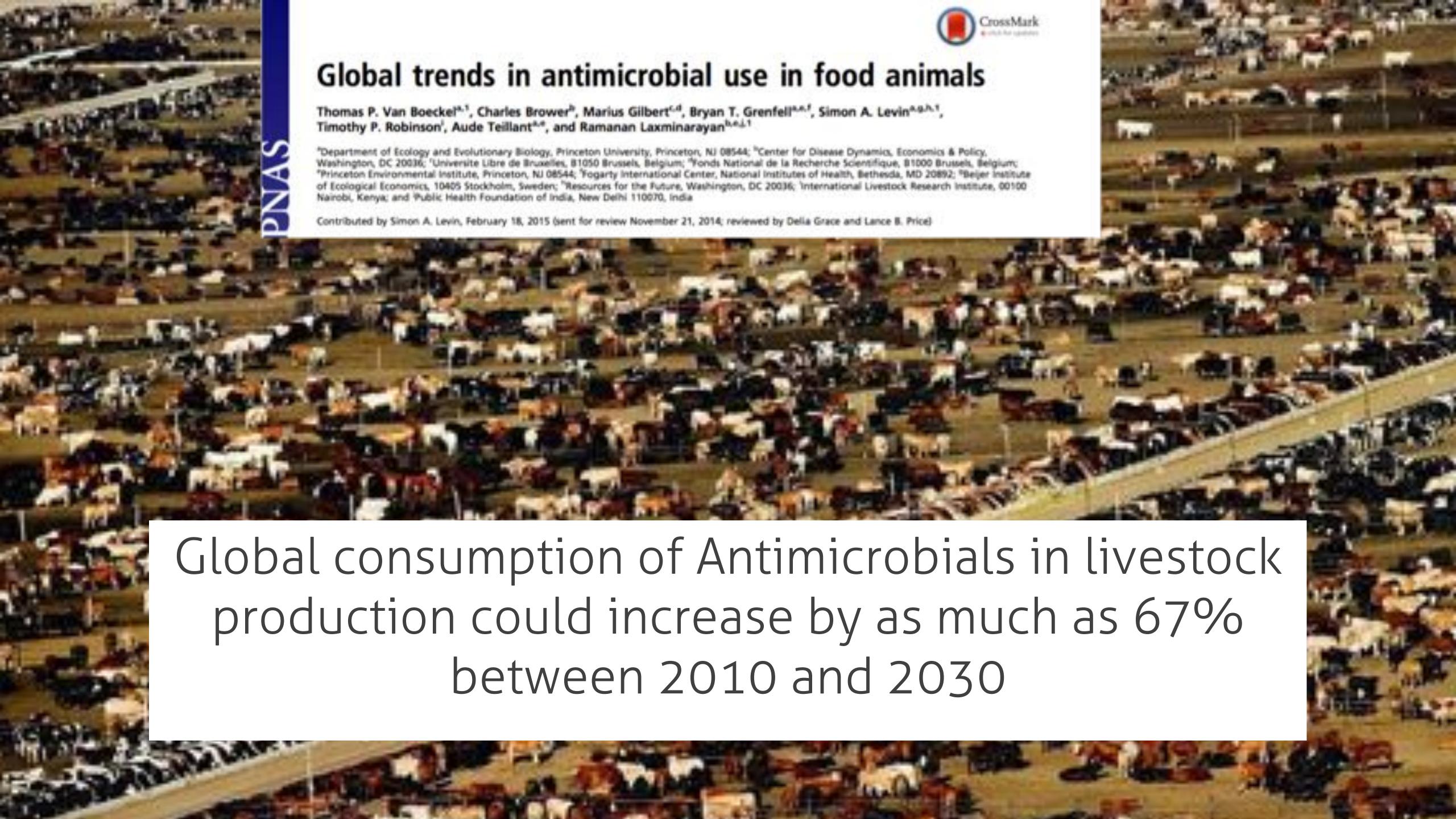


Aquaculture and AMR (Antimicrobial Resistance)

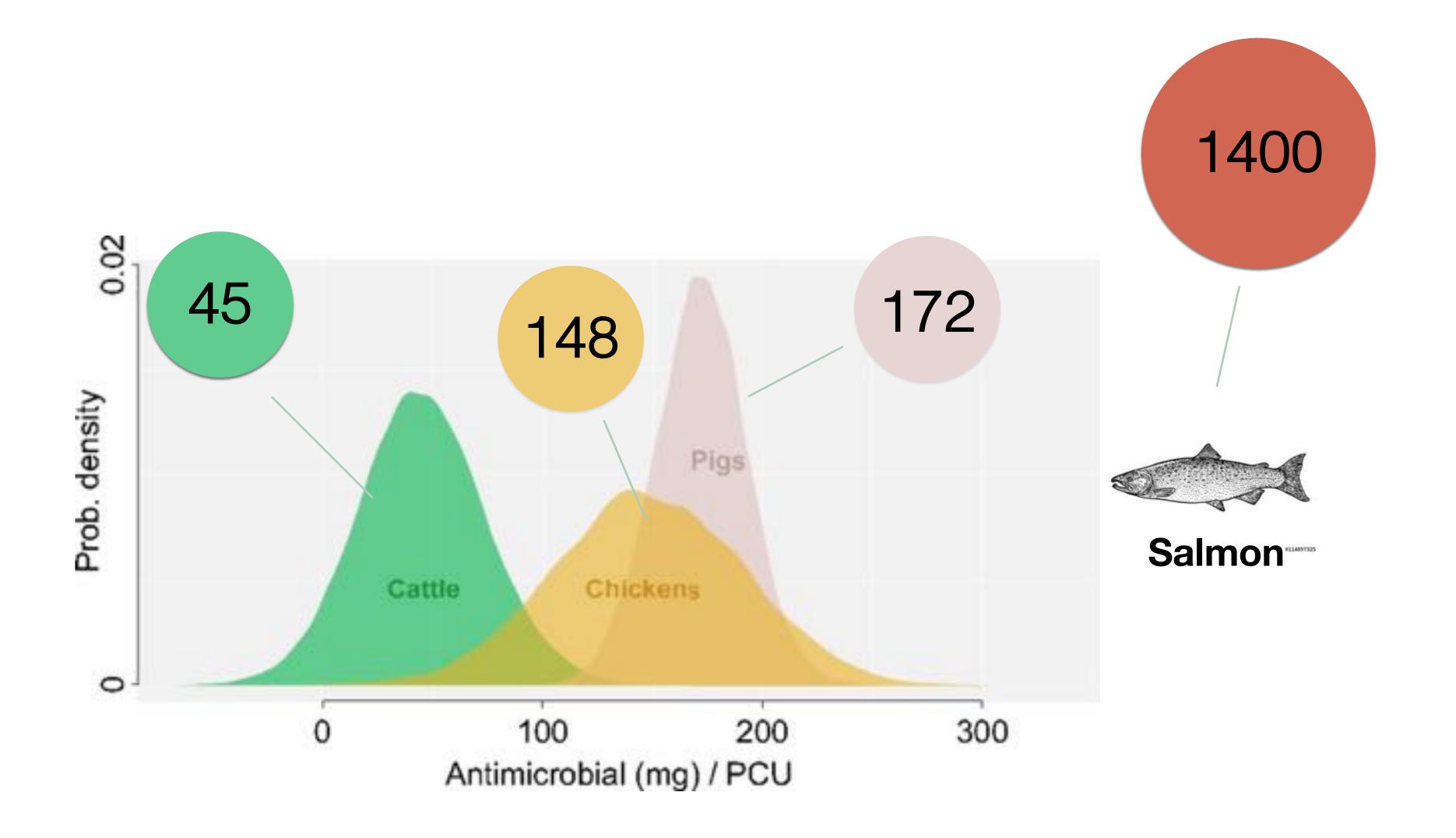
GLOBAL URGENCY- ANTIMICROBIAL RESISTANCE

"The spread of AMR bacteria – is one of the major threats for the human population of the twenty-first century"

World Health Organization (WHO)



Posterior distributions for estimates of antimicrobial consumption in cattle, chickens, and pigs in OECD countries.

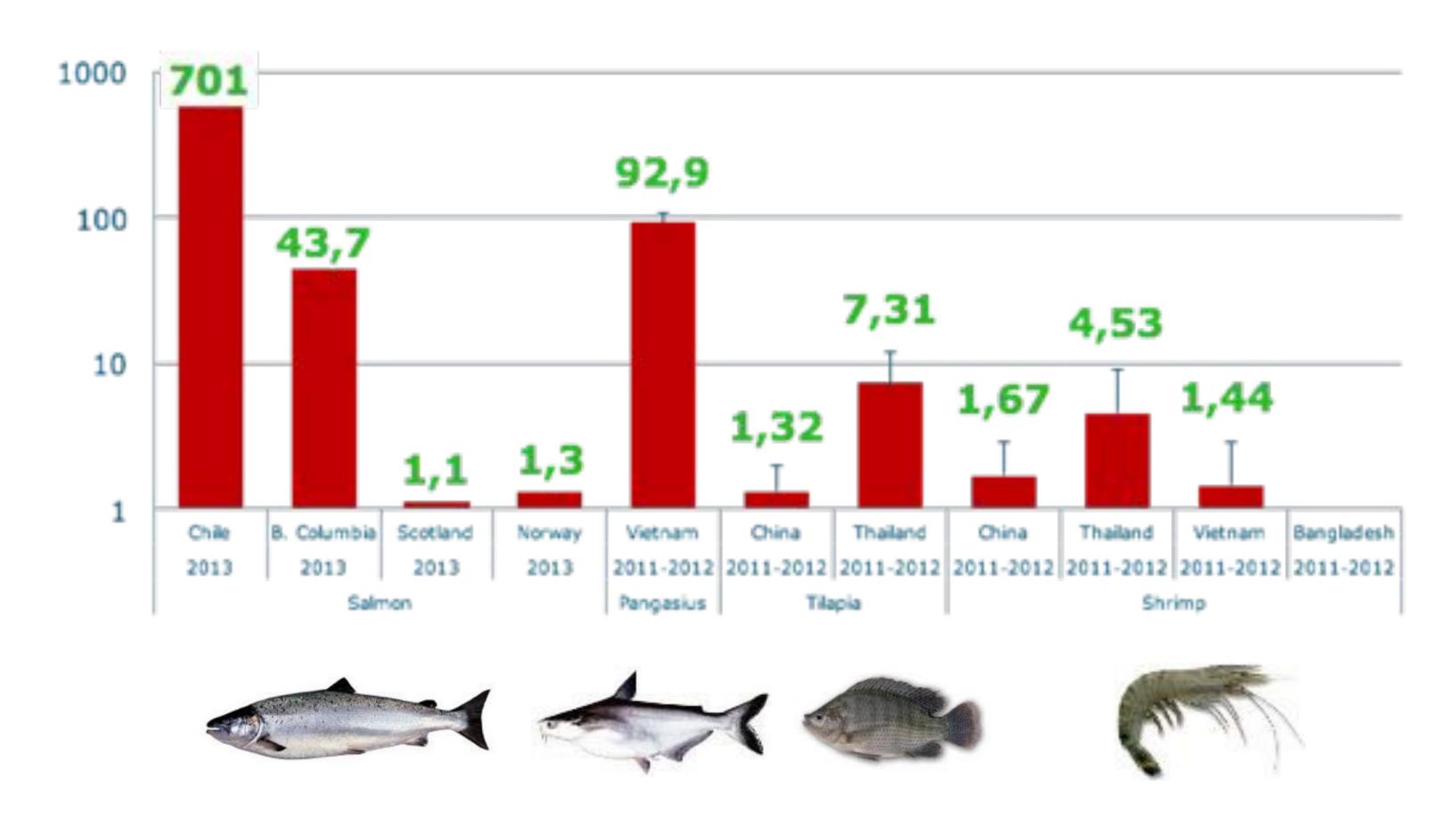


Thomas P. Van Boeckel et al. PNAS 2015;112:5649-5654

Antibiotic use in Aquaculture

Varying among species and production practices

mg a.i. / kg



Data sources:

Bridson P. 2014. Four Region Summary Document: Salmon. MBA Seafood Watch

Rico et al. 2013 Aquaculture

Recent work

"Unpacking factors influencing antimicrobial use in global aquaculture and their implication for management: a review from a systems perspective"



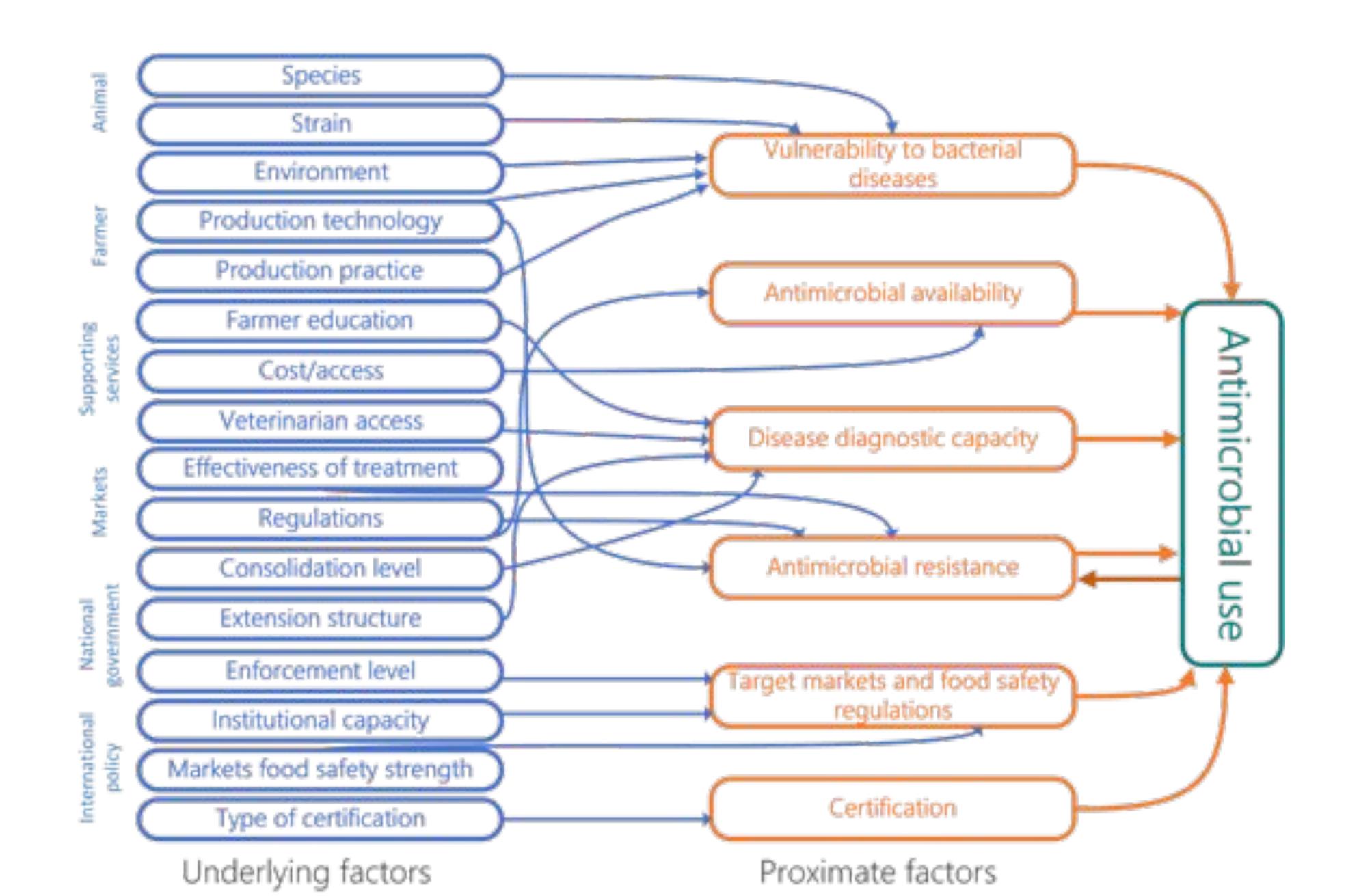
GLOBAL URGENCY- RESISTANCE

Can be unregulated, unprescribed use of generic non-approved substances

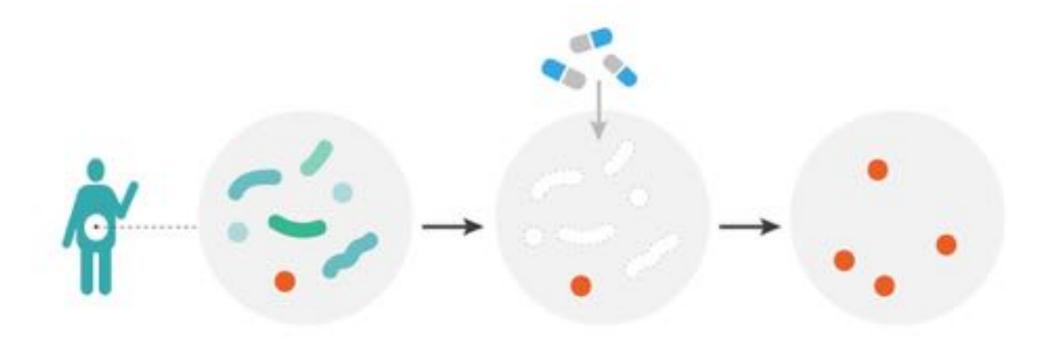
Typically no insights in dose/response - both overand under dosing drive resistance

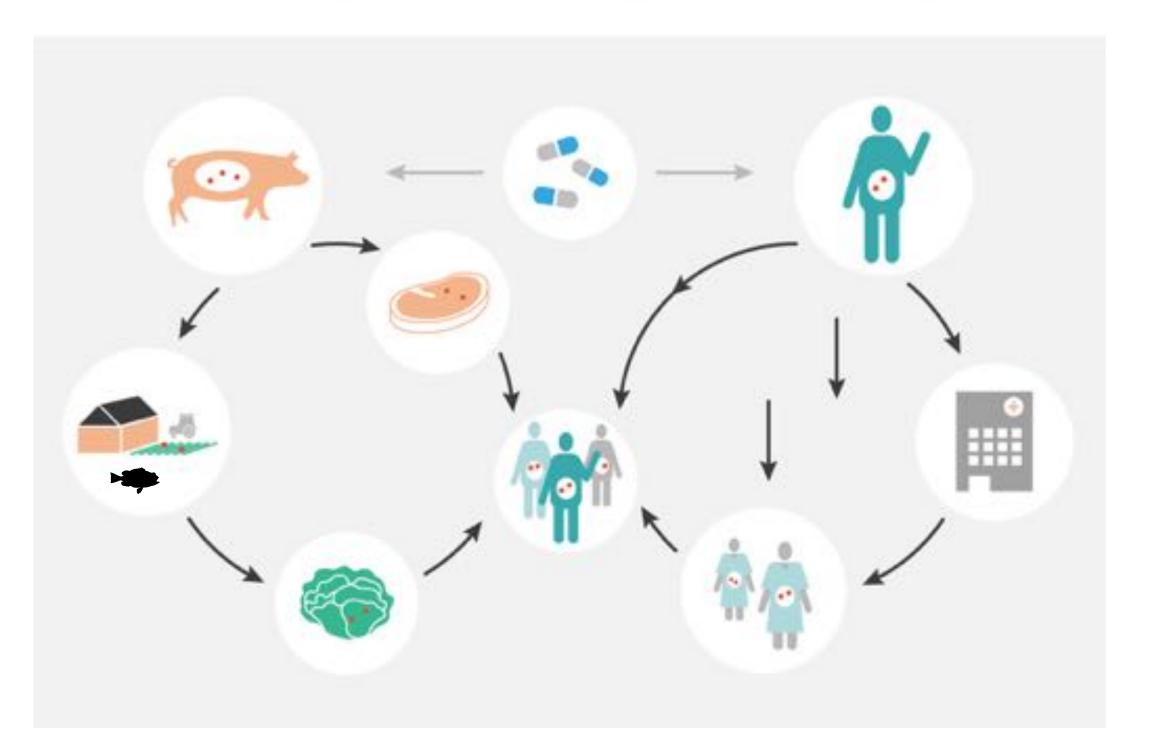
Different farmed species pose different challenges related to AMU and AMR risks

Factor Identification



"One health"







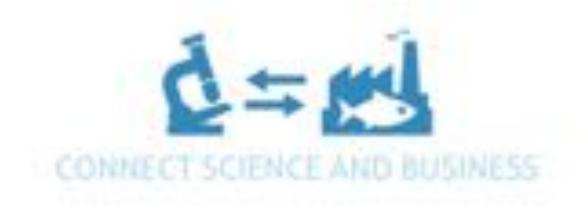
Seafood Transformation

SEABOS Initiative

THE INITIATIVE

Seafood Business for Ocean Stewardship

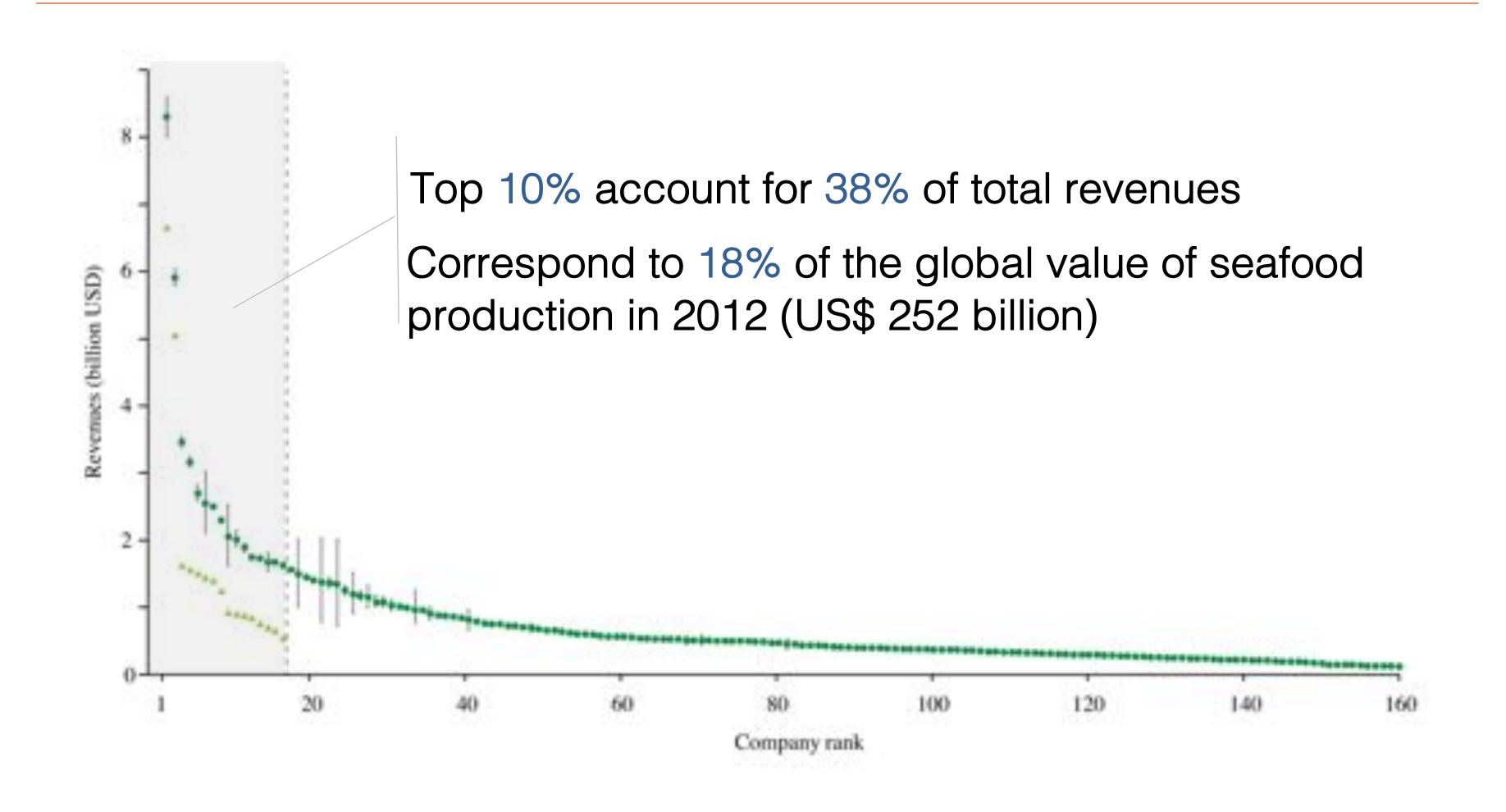
Seafood Business for Ocean Stewardship (SeaBOS) is an initiative resulting from a series of Keystone Dialogues between scientists and seafood companies. The Keystone Dialogue aims to explore whether or not a small number of "Keystone Actors" have the potential to transform the global seafood system. The SeaBOS initiative is an expression of interest from industry to explicitly test the hypothesis that a small minority of powerful actors can influence a majority of smaller actors. For the first time, the initiative connects the global seafood business to science, connects wild capture fisheries to aquaculture, and connects European and North American companies to Asian companies. The ambition is to lead a global transformation towards sustainable seafood production and a healthy ocean. The initiative will actively contribute to the United Nations Sustainable Development Goals (SDGs), and in particular Goal 14 – Conserve and sustainably use the oceans, seas and marine resources.







Concentration in the seafood industry-Keystone actors















"Transparency of the value chain is increasingly important in food and especially aquaculture, with consumers paying more attention to the origin of feed"

SEAFOOD BUSINESS FOR OCEAN STEWARDSHIP



-- JOINT STATEMENT --

SeaBOS and GDST Join Forces for Seafood Traceability

The Seafood Business for Ocean Stewardship (SeaBOS) and the Global Dialogue on Seafood Traceability (GDST) are joining forces in support of seafood traceability. Our two leading seafood industry groups—which together include seven of the world's ten largest seafood production companies with combined seafood sales of well over USD \$35 billion per year—are now pledging to work jointly towards the adoption of global industry standards to improve the quality, efficiency, and affordability of seafood traceability. These unprecedented pre-competitive voluntary standards will equip the seafood sector for the 21st Century's globalized, information-based economy, and will help make digital seafood traceability a universal industry practice.

Global industry standards for seafood traceability are urgently needed to eliminate costly and unnecessary barriers between the dozens of incompatible, proprietary traceability systems that exist today, and to help guide governments towards the harmonization of standards affecting seafood trade. By creating a set of voluntary industry norms, the seafood sector will:

- Develop shared expectations about the kinds and quality of information entering seafood supply chains;
- Ensure that fishing and aquaculture enterprises around the world receive more consistent and predictable demands for the data accompanying their products;
- Create a level playing field that promotes equitable market access for large and small producers from diverse countries;
- Establish technical protocols for interoperability that will facilitate digital communication among thousands of actors across the seafood supply chain; and
- Provide a basis for more efficient and consistent regulatory practices among producer, processor, and market country governments.

Together, the SeaBOS and GDST initiatives currently represent more than five dozen companies from across the global seafood supply chain, ranging from major multinational players to representatives of small-scale producers in Asia, Europe, and the Americas. We believe that reliable traceability is critical for effective supply chain management, and for ensuring that seafood is sourced from production practices that are legal, sustainable, and socially responsible.

SeaBOS was established in December 2016 under the auspices of the Keystone Dialogues to bring together the world's largest and most influential seafood companies

SEABOS commitment

"We will act on the following......

Work towards reducing the use of antibiotics in aquaculture!



Ongoing work

- 1. Characterization of Seaboses farming portfolios?
- 2. Mapping existing Seabos strategies and policies related to antibiotic use
- 3. Linking to international initiatives with respect to AMR
 - 4. Broader AMR Perspectives "One health"

Ongoing work

Some SeaBOS members already have policies regarding antibiotic use....











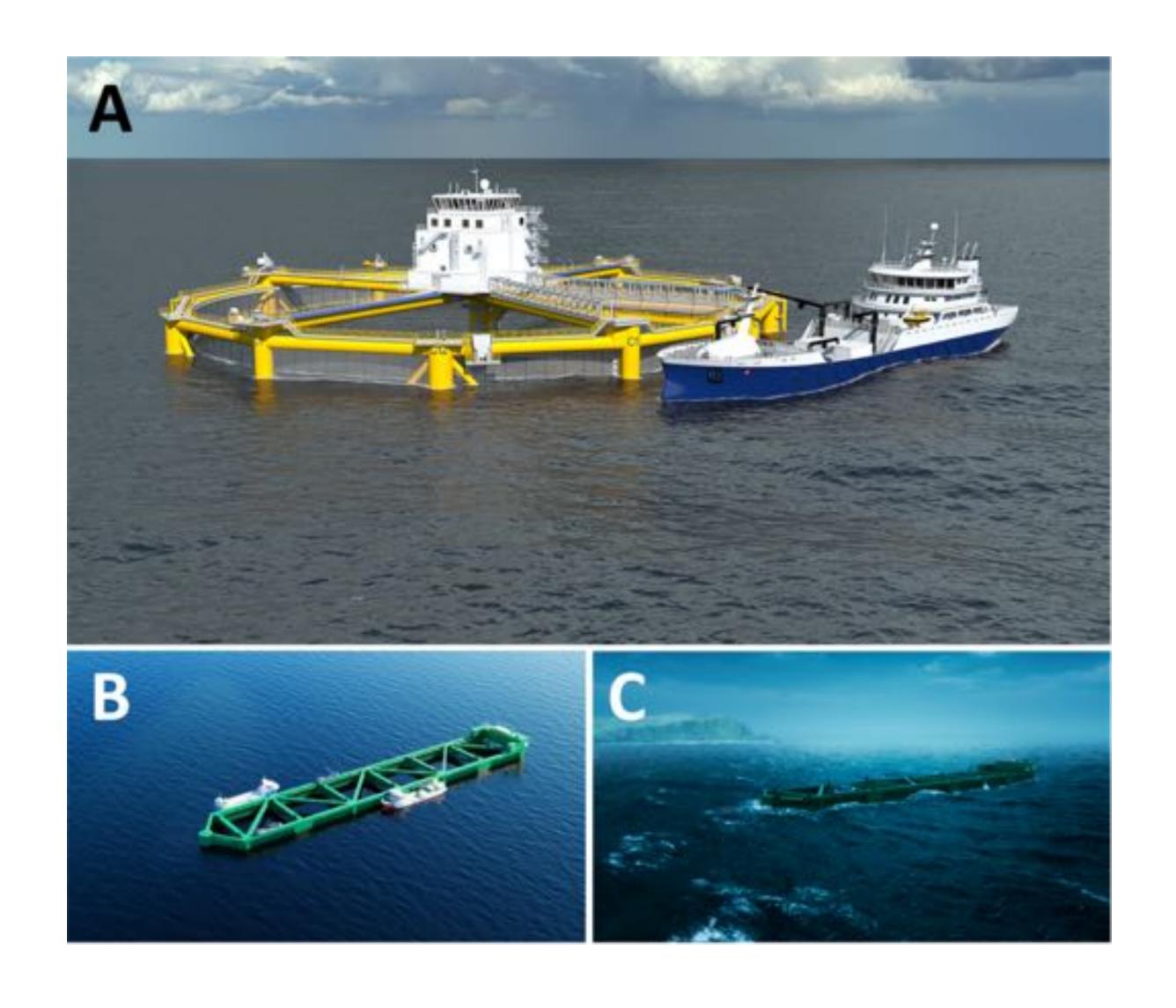
- Appropriate antibiotics for fish farming
- Veterinary use only
- Comply with local / regional legislation

The many subsidiaries a challenge for many of the Seabos members

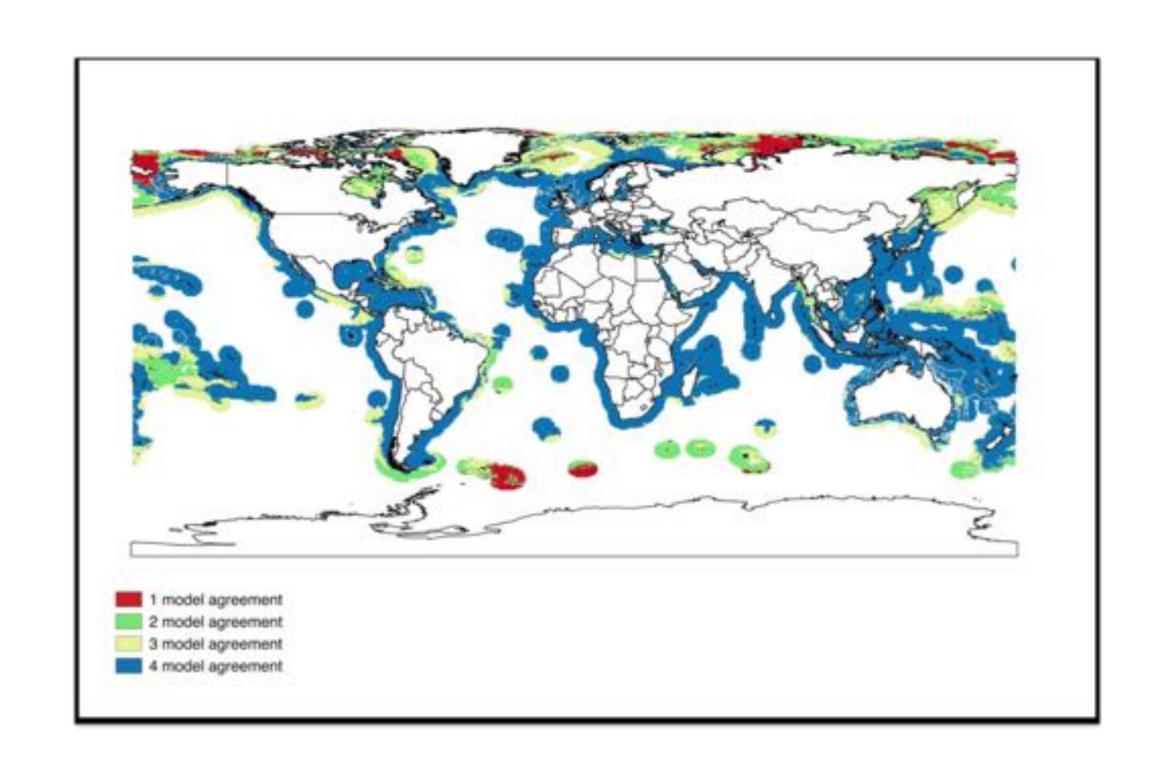


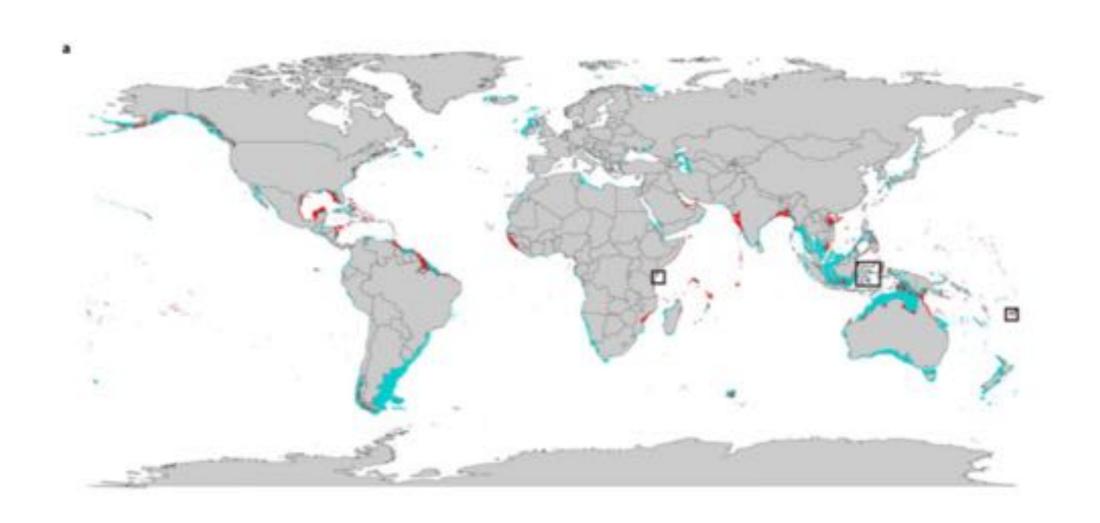
Into the ocean!

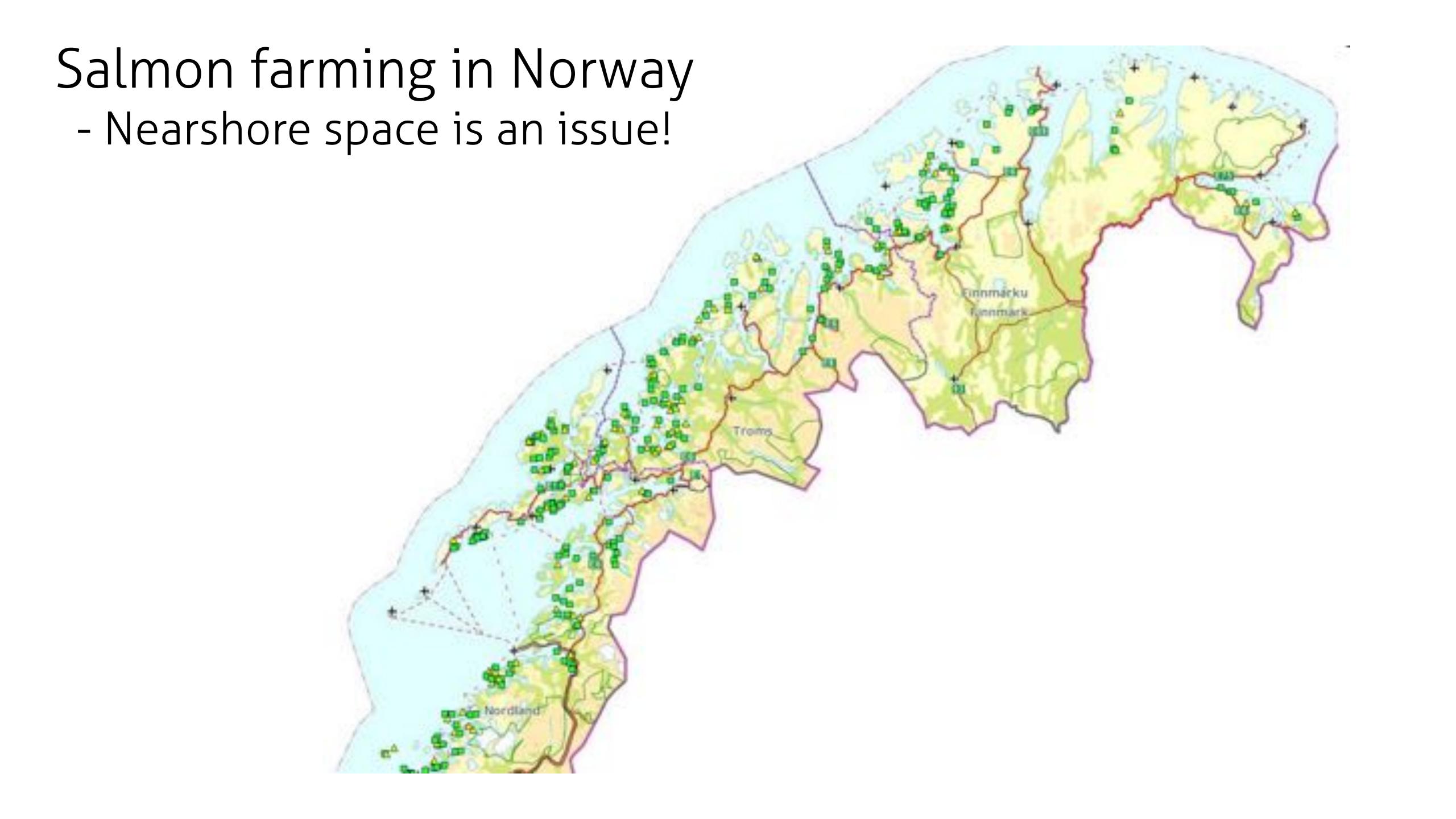
Recent off-shore aquaculture innovations



"Sea space not limiting"







Feeds, costs and risks







Harmful Algal Blooms

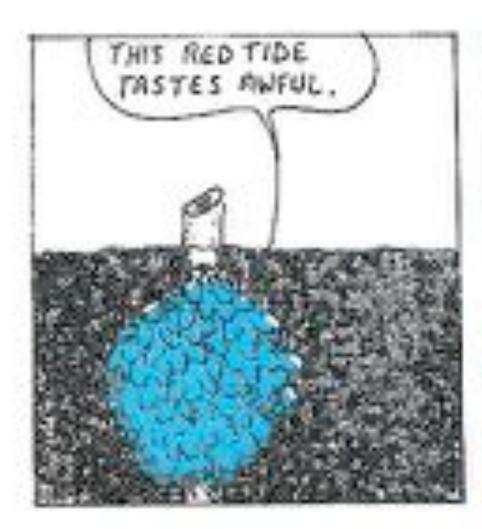
IntraFish



UPDATE: Algal bloom wipes out 58,000 fish at Salmones Camanchaca farm

Sernapesca activates 'mass mortality' alert.

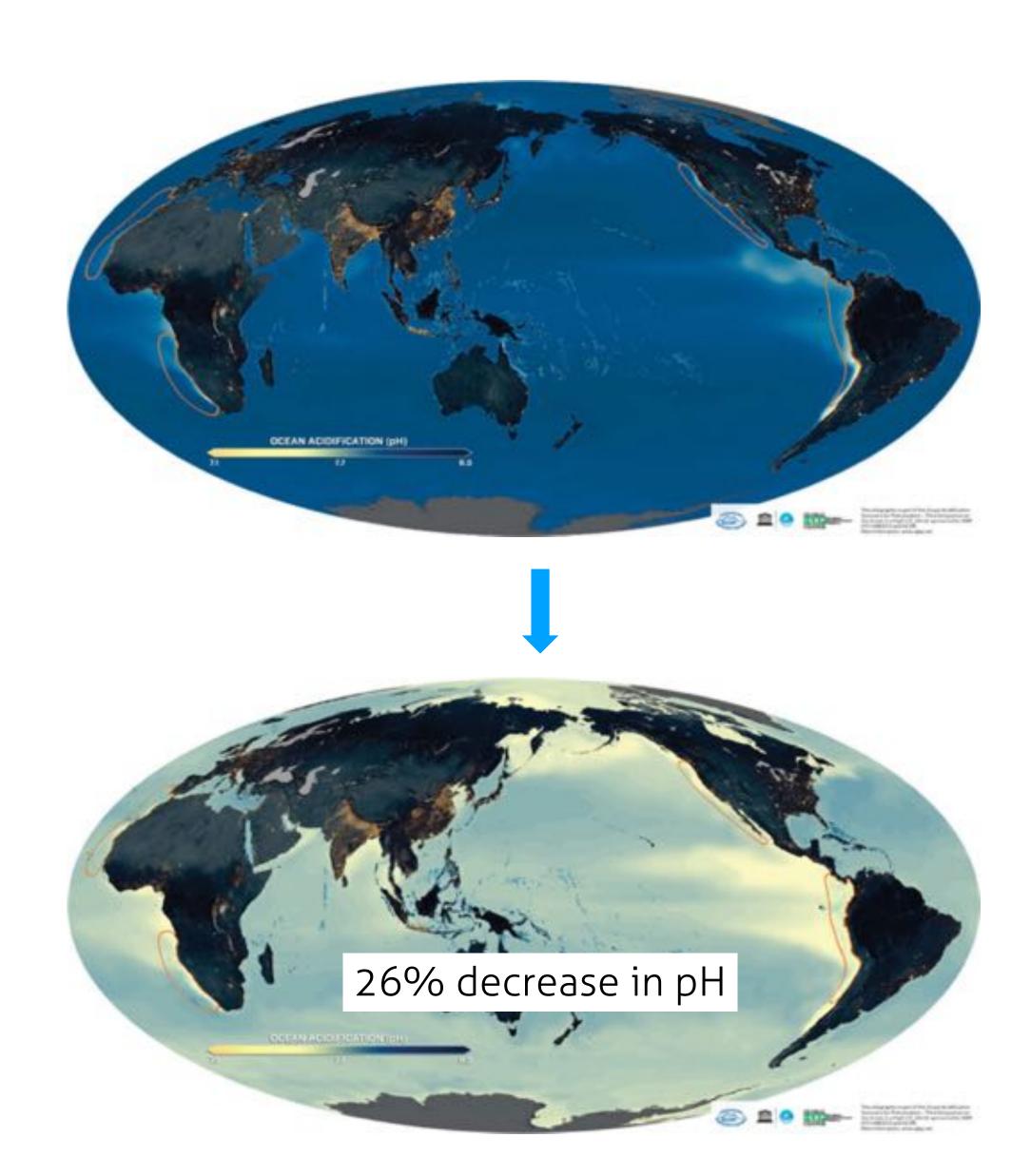
Salmones Camanchaca reported an "abrupt and sudden" massive salmon mortality event at its Pilpilehue center, Chiloe, on March 14, Chile's National Service of Fisheries and



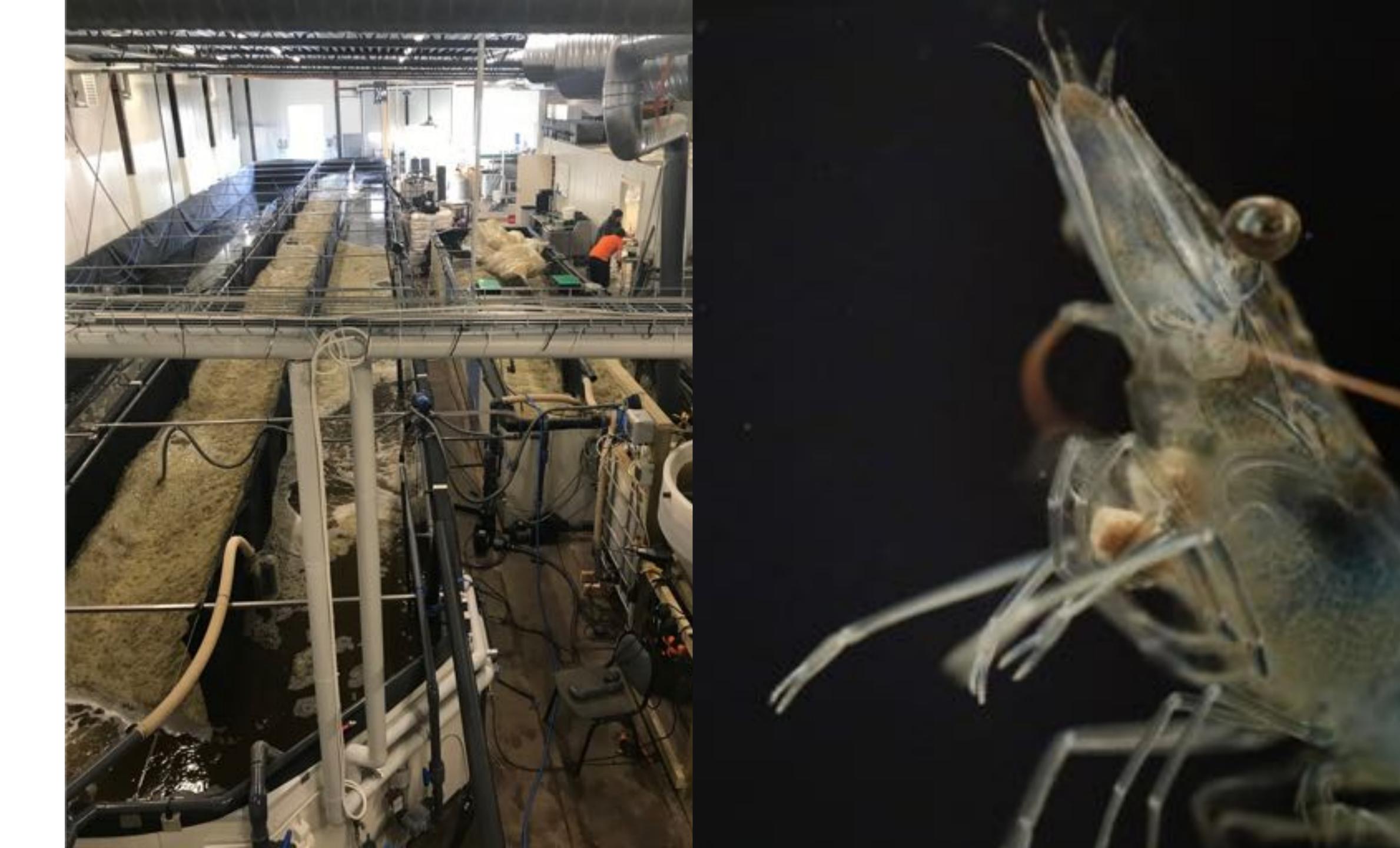


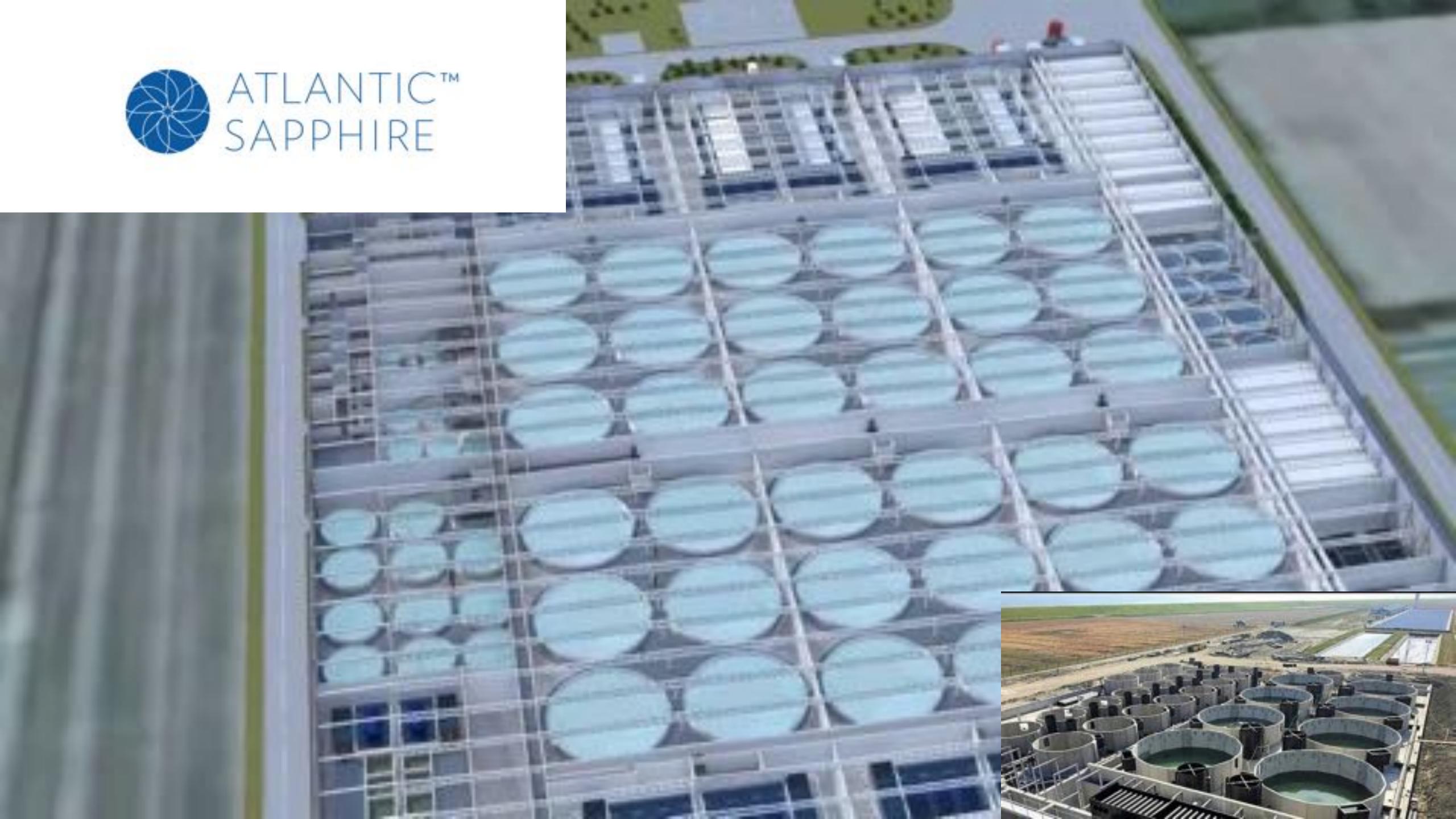


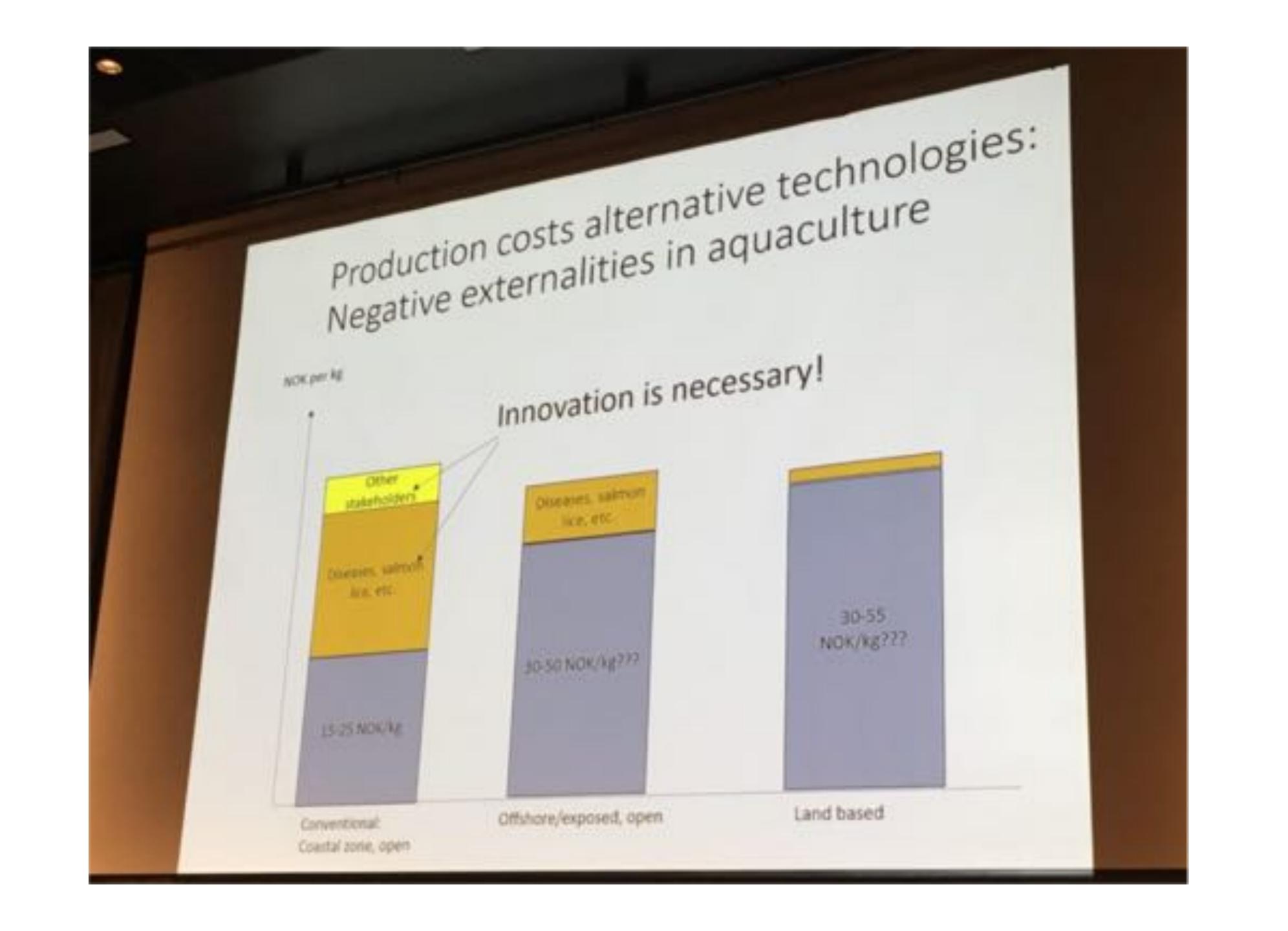
Ocean Acidification











Something on feeds

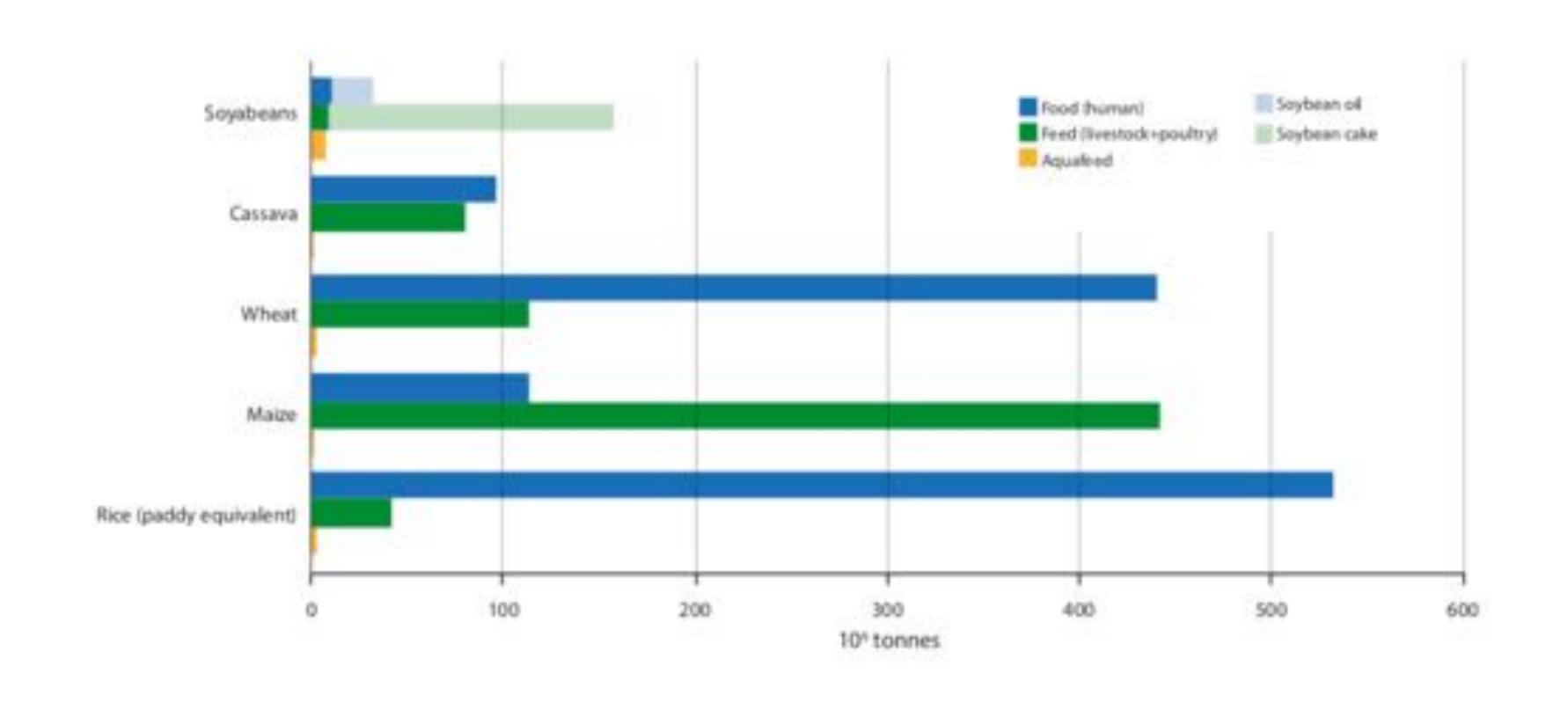




Agriculture feed resources



Agriculture inputs to animal farming – including aquaculture



Data for 2010

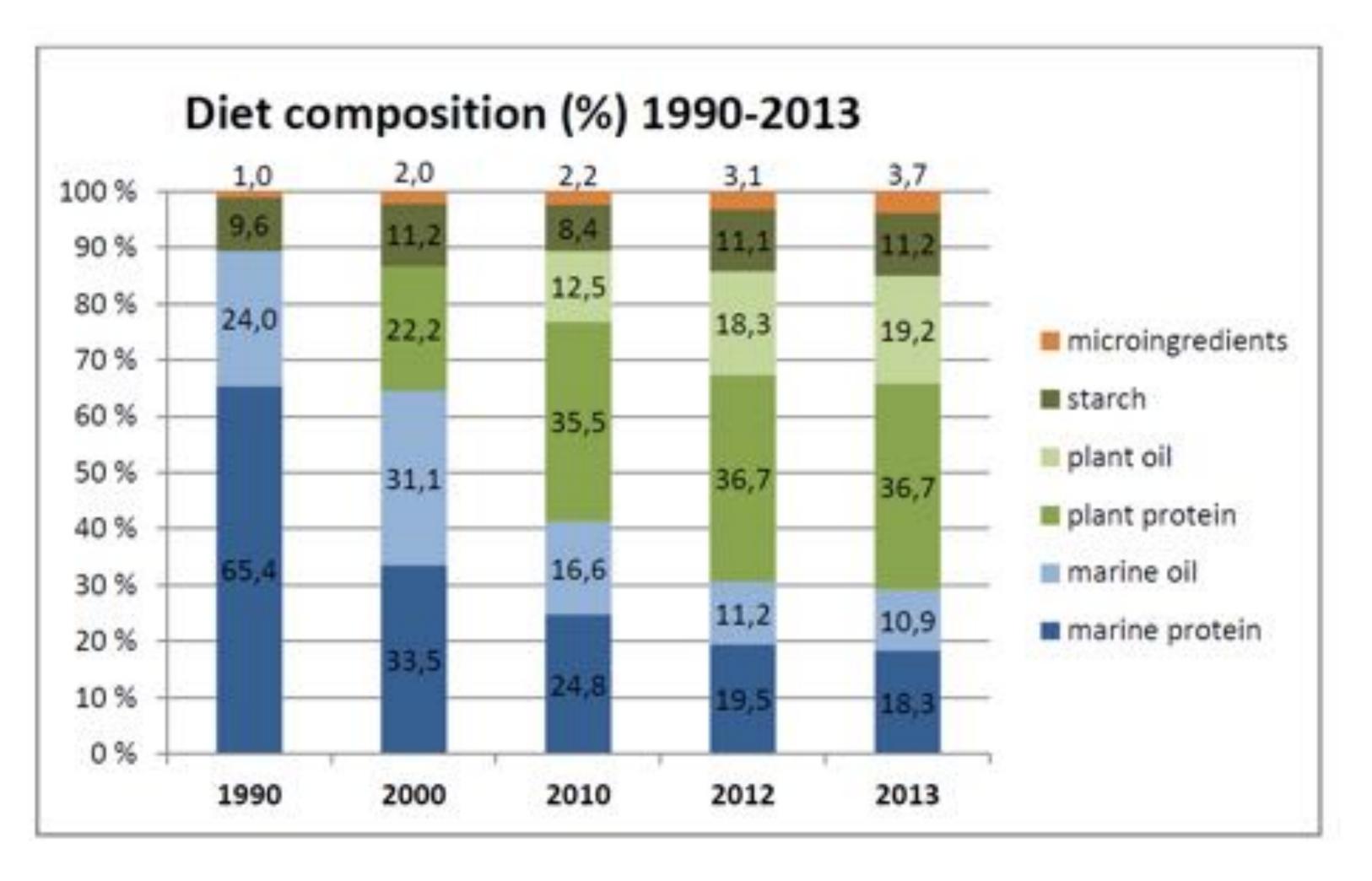


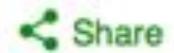
Figure 7 Development of salmon feed in Norwegian salmon farming from 1990 to 2013.

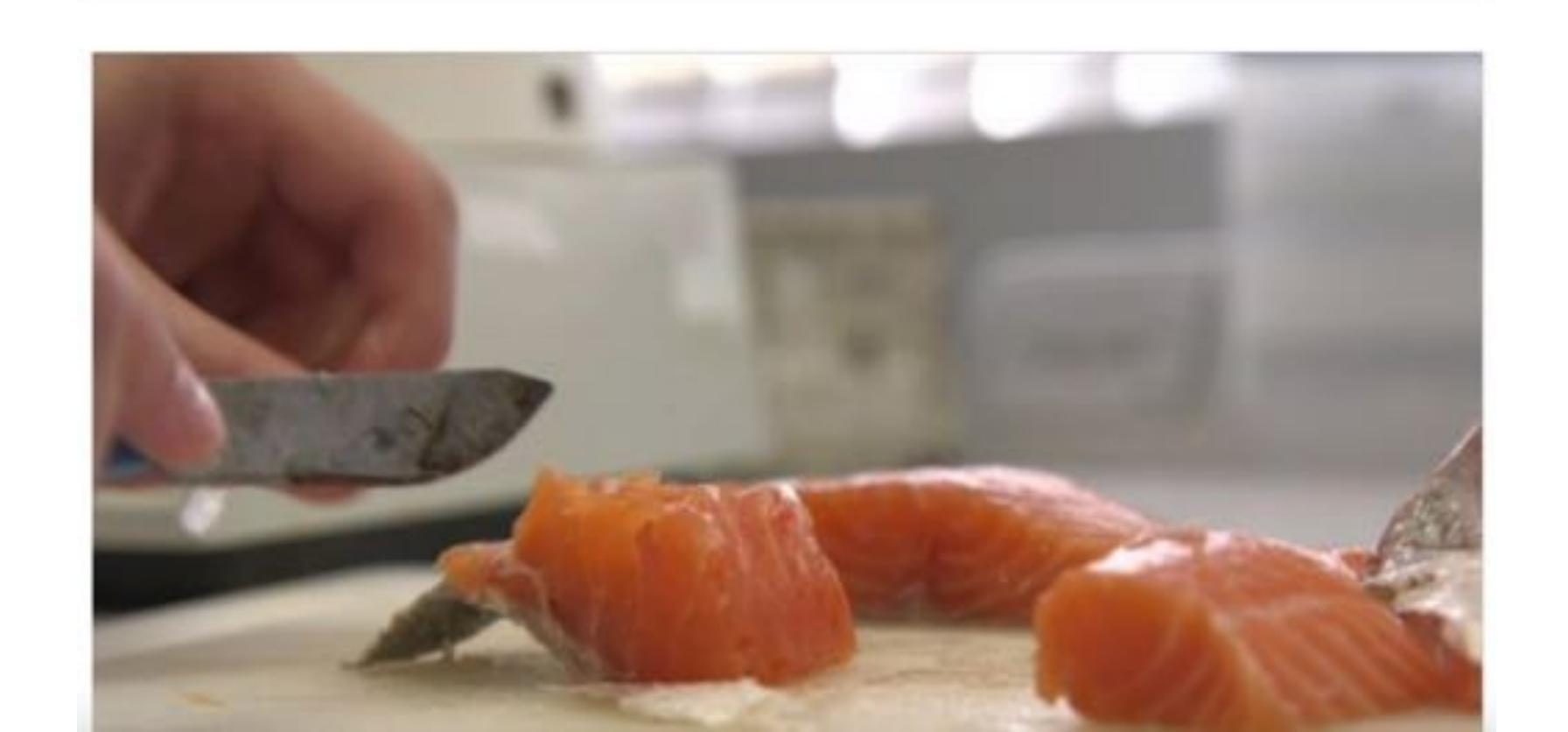


Omega-3 oils in farmed salmon 'halve in five years'

By Pallab Ghosh Science correspondent, BBC News

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Alternative feeds

- Microalgae
- Macroalgae
 - Bacteria
 - Yeast
 - Insects
 - Krill
 - Etc.













