

Jornadas de Engenharia do Ambiente 2014

Painel Água



Aquacultura – o novo período Neolítico

<http://goodclam.org/jeamb>

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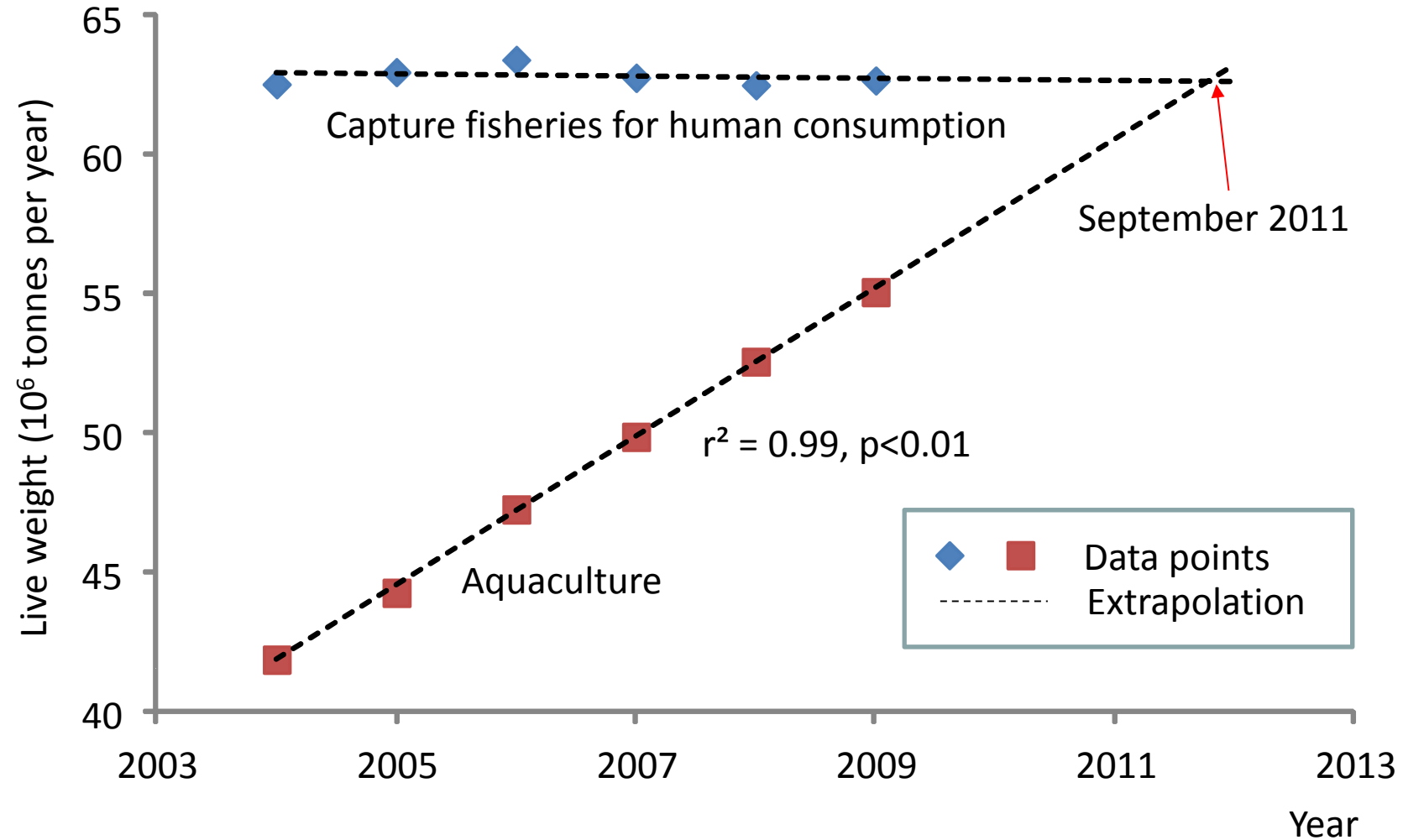
Lisboa, 18 de Fevereiro 2014

Talk outline

- The new Neolithic – food from the sea (4)
- Sustainability and carrying capacity (8)
- Virtual tools for aquaculture (7)
- New ideas, going offshore? (6)
- Synthesis (1)

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Trends in fisheries and aquaculture



Equivalent to the emergence of agriculture 10,000 years ago in the Neolithic period

Aquaculture in Europe and the world

Volume and value

Fast (FAO) facts

- 90% of the 68 million tonnes (Mt) of aquaculture products (105 billion USD) originate from Asia (Sorgeloos)
- Production of striped catfish *Pangasius* in the Mekong delta is >1 Mt y^{-1} , highest yields in the world, 350-400 tonnes ha^{-1} per crop (Sena da Silva)
- 30 Mt y^{-1} of extra aquatic products required to feed the planet by 2050 (Swaminathan)
- US predicted expansion from 0.5 to 1.5 Mt y^{-1} (Olin)
- Europe: production is 4.2% by volume, 9.1% by value (Sorgeloos)

Growth of both population and aquaculture will take place in developing nations.

Aquaculture in Europe

Sustainability and legislation

Environmental, legal, and social pressures

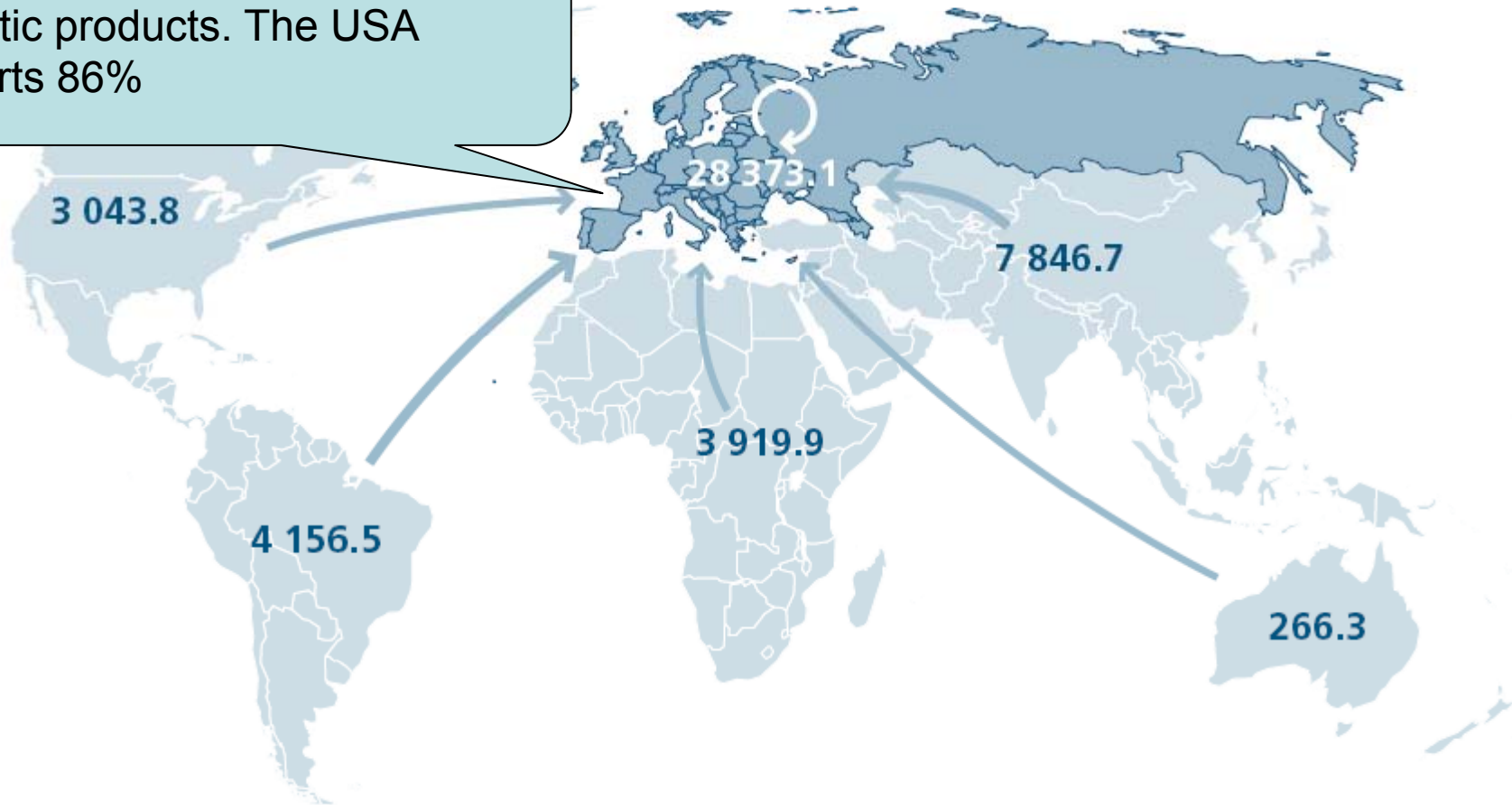
- Aquaculture is the most heavily regulated food production sector in Europe (Varadi)
- Competition for space, access to capital, availability of special services, limited authorised veterinary products (Varadi)
- Water Framework Directive (2000/60/EC) – no reference to aquaculture. Benthic biodiversity, fish (in transitional waters); Good Ecological Status in Europe by 2015
- Marine Strategy Framework Directive (2008/56/EC) – Fish and Shellfish Quality Descriptor (QD3). Aquaculture is seen only as a pressure. Good Environmental Status by 2020
- Many other parts of the world don't come close to the EU regulatory panorama

In all likelihood Europe will add value over volume.

Imports to Europe

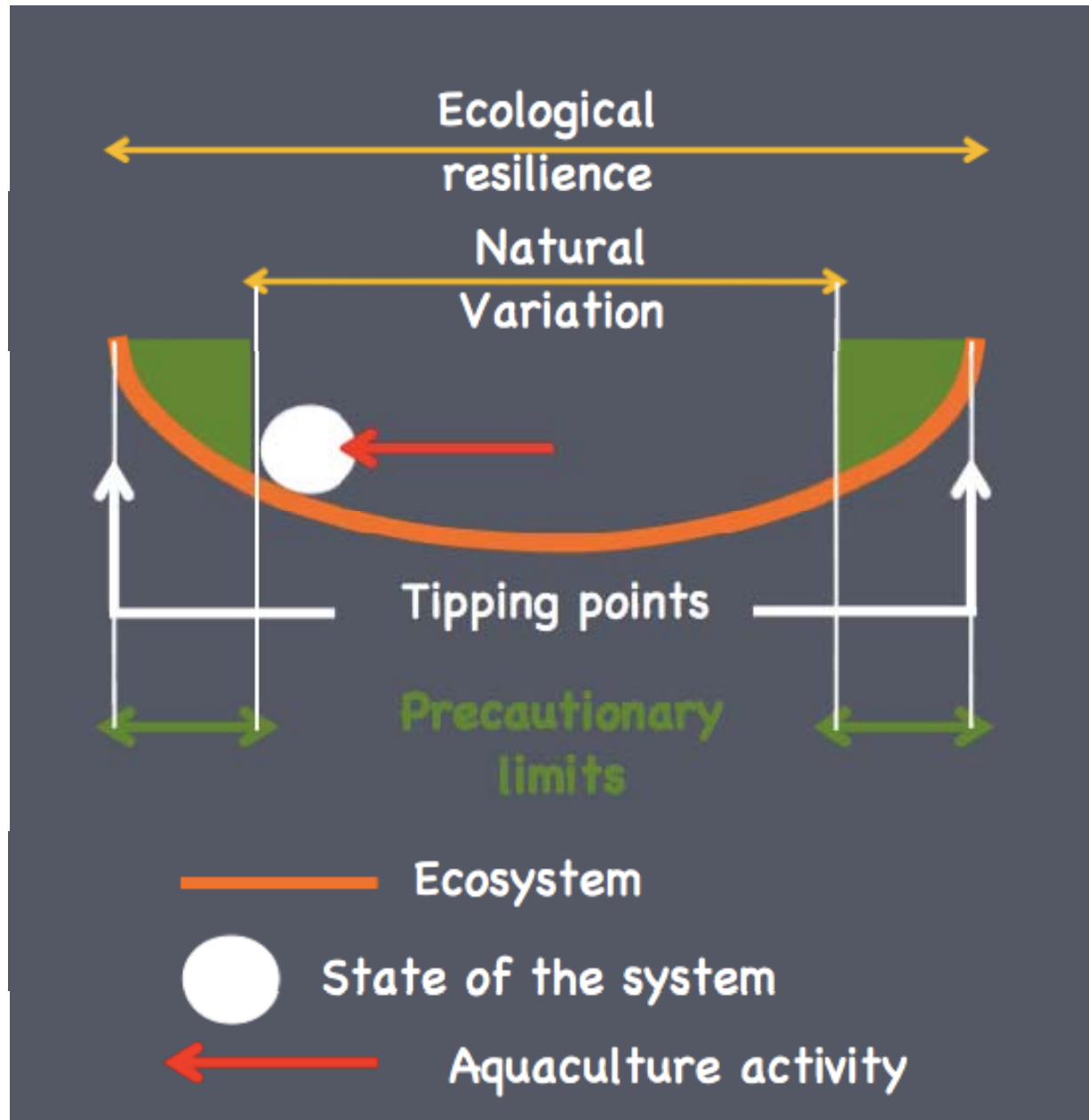
All numbers in millions of USD (SOFIA 2012)

Europe imports 74% of its aquatic products. The USA imports 86%



If European consumption was at the level of Portugal (57.4 kg y⁻¹ per capita) an extra 27 million tonnes of fish products would be required annually.

Sustainability criteria: foundation in classical ecology



Over carrying capacity farming



Zhu, 2010

Rapid overstocking...

- Yellow croaker cage farming was started in Sandu Bay in 1995, **1000** fish cages in Qingshan, 1996.
- **50,000** fish cages in Qingshan, (**260, 000** fish cages in the whole Sandu Bay,) 2005
- Carrying capacity research indicated 40% of the cages should be removed in 2005, but things remain unchanged.



THEIR PHOTO: APR 25, 2005



名升网
nm111.net

Zhu, 2010

Ecosystem Approach to Aquaculture (the gospel according to FAO)

Three principles

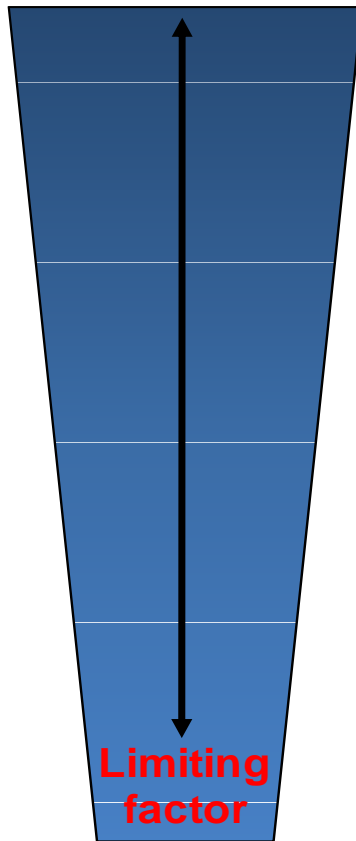
- Aquaculture should be developed in the context of ecosystem functions and services (including biodiversity) with no degradation of these beyond their [resilience](#);
- Aquaculture should improve human-well being and equity for all relevant stakeholders;
- Aquaculture should be developed in the context of other sectors, policies and goals.

Soto, 2010

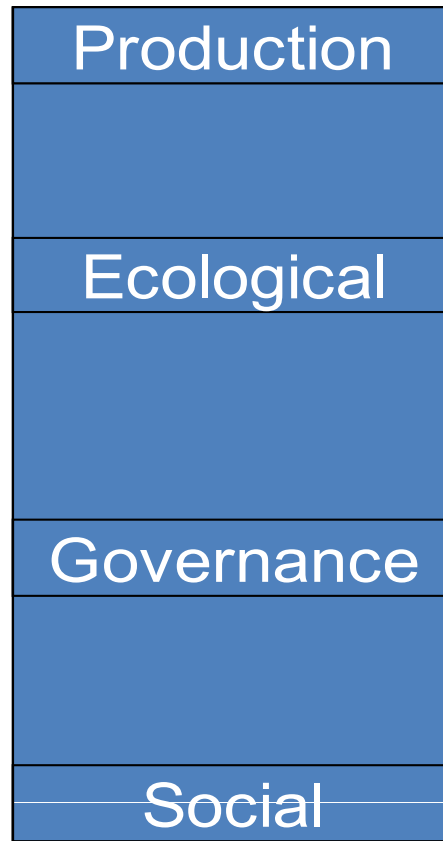
EAA: ecosystem balance, social equity, multiple uses

Different types of carrying capacity for aquaculture

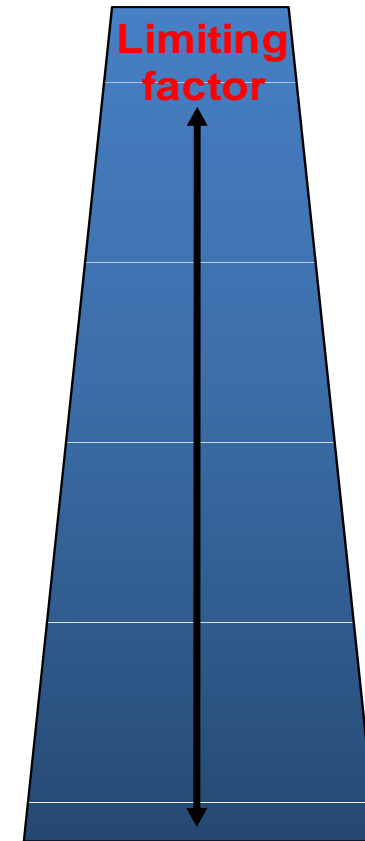
**US, Europe,
Canada**



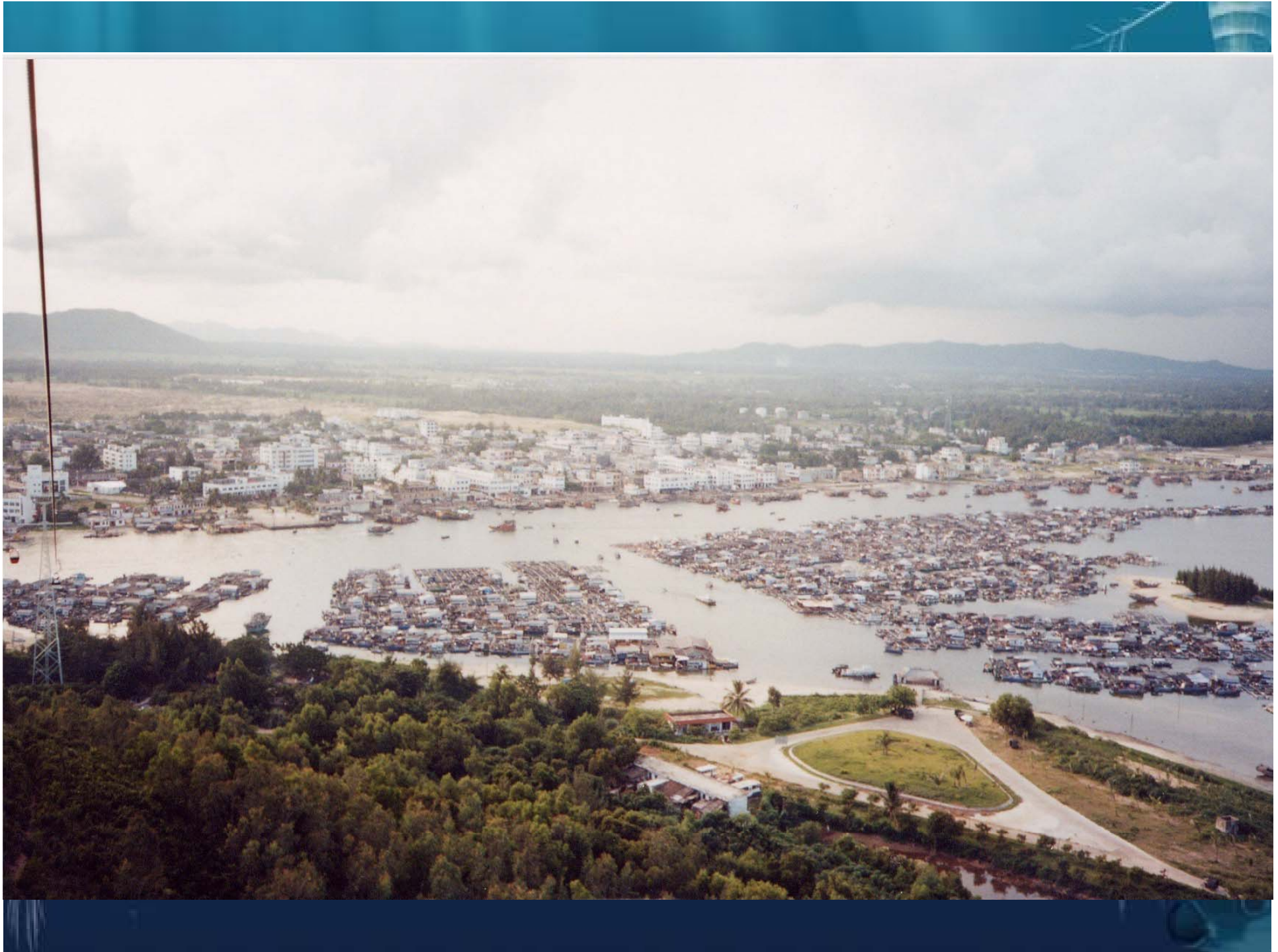
Types of carrying capacity



**Southeast Asia,
China**



Different parts of the world see carrying capacity in very different ways



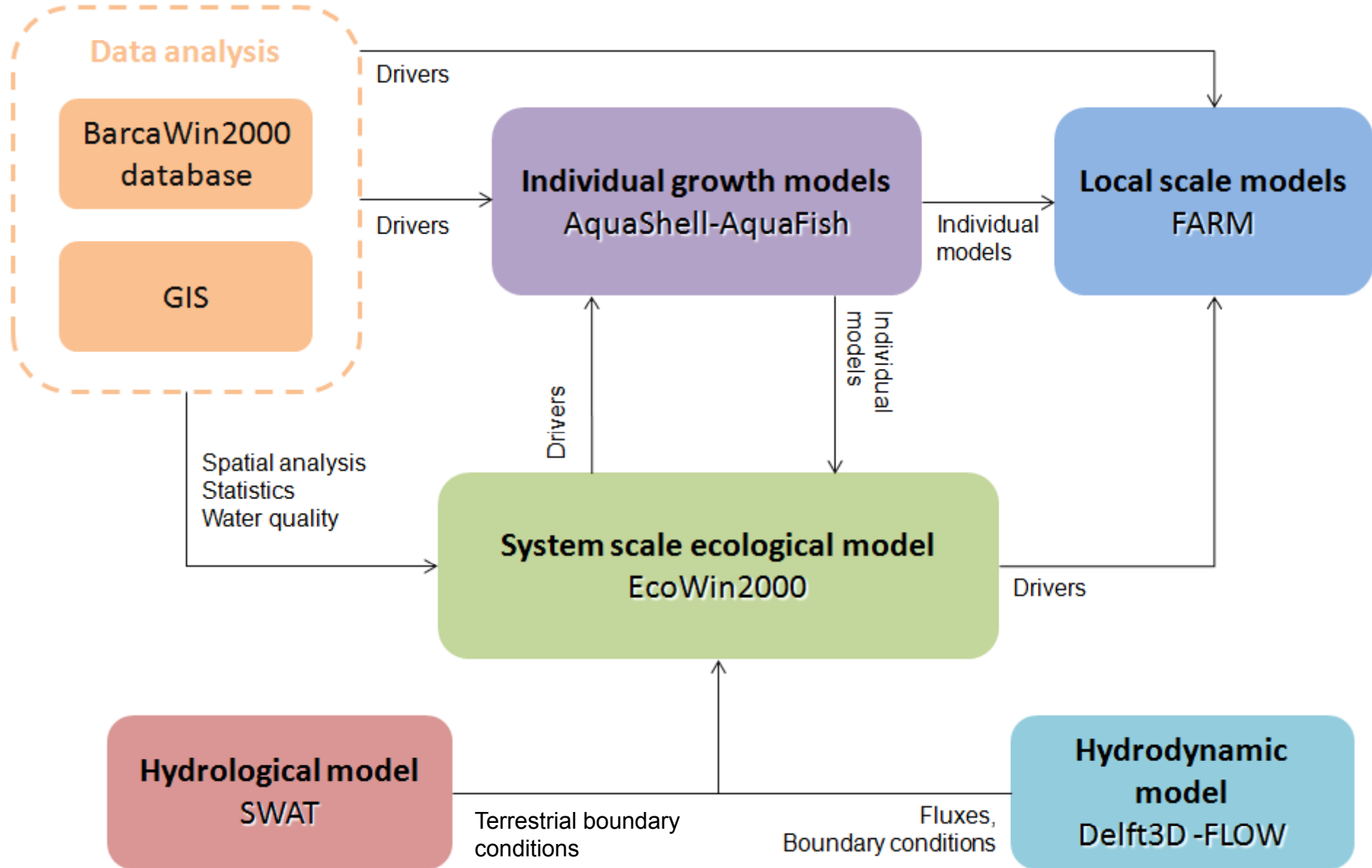
Sanggou Bay

IMTA with Japanese seabass, oysters, seaweed, and abalone



Longlines as far as the eye can see. Oyster ropes drop from the lines, abalone are cultivated on the bottom.

FORWARD and COEXIST modelling framework



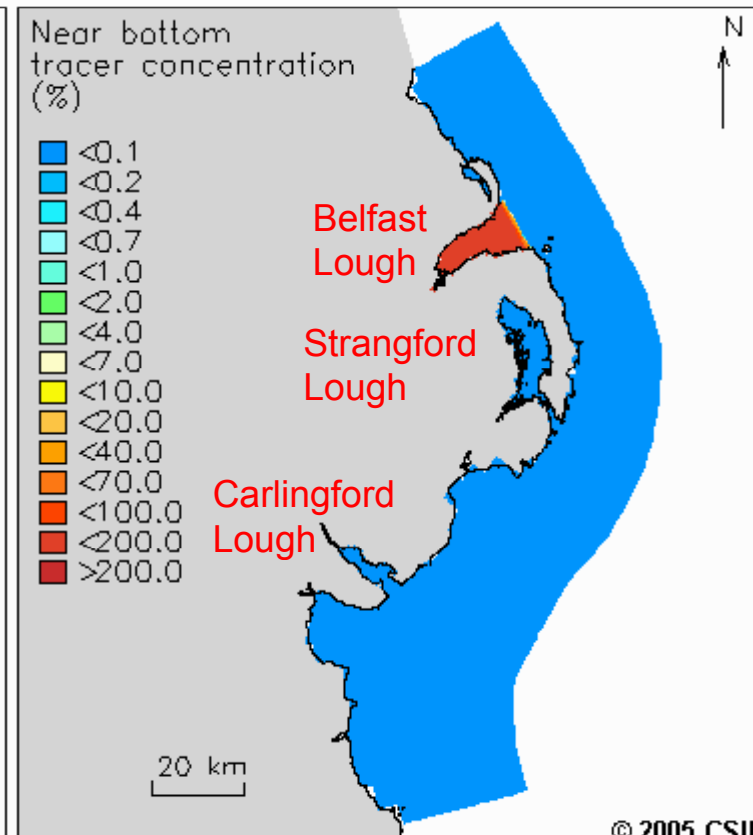
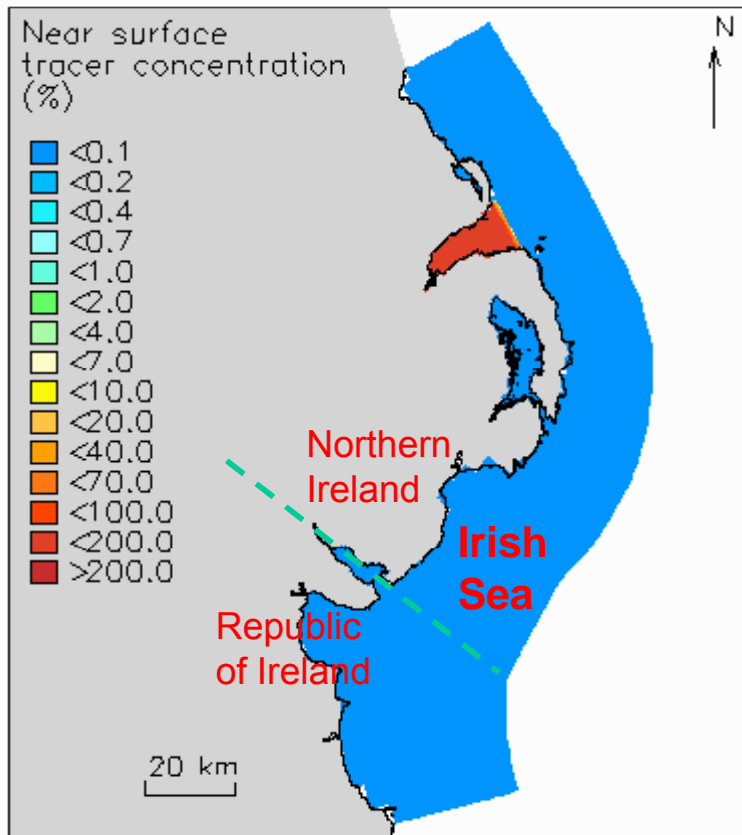
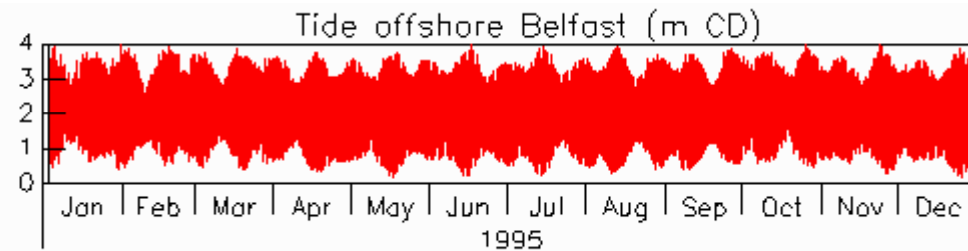
Different models for different questions. Scales are from minutes to decades.

From technologies to tools

Example: Stage 1. Circulation model – connected systems

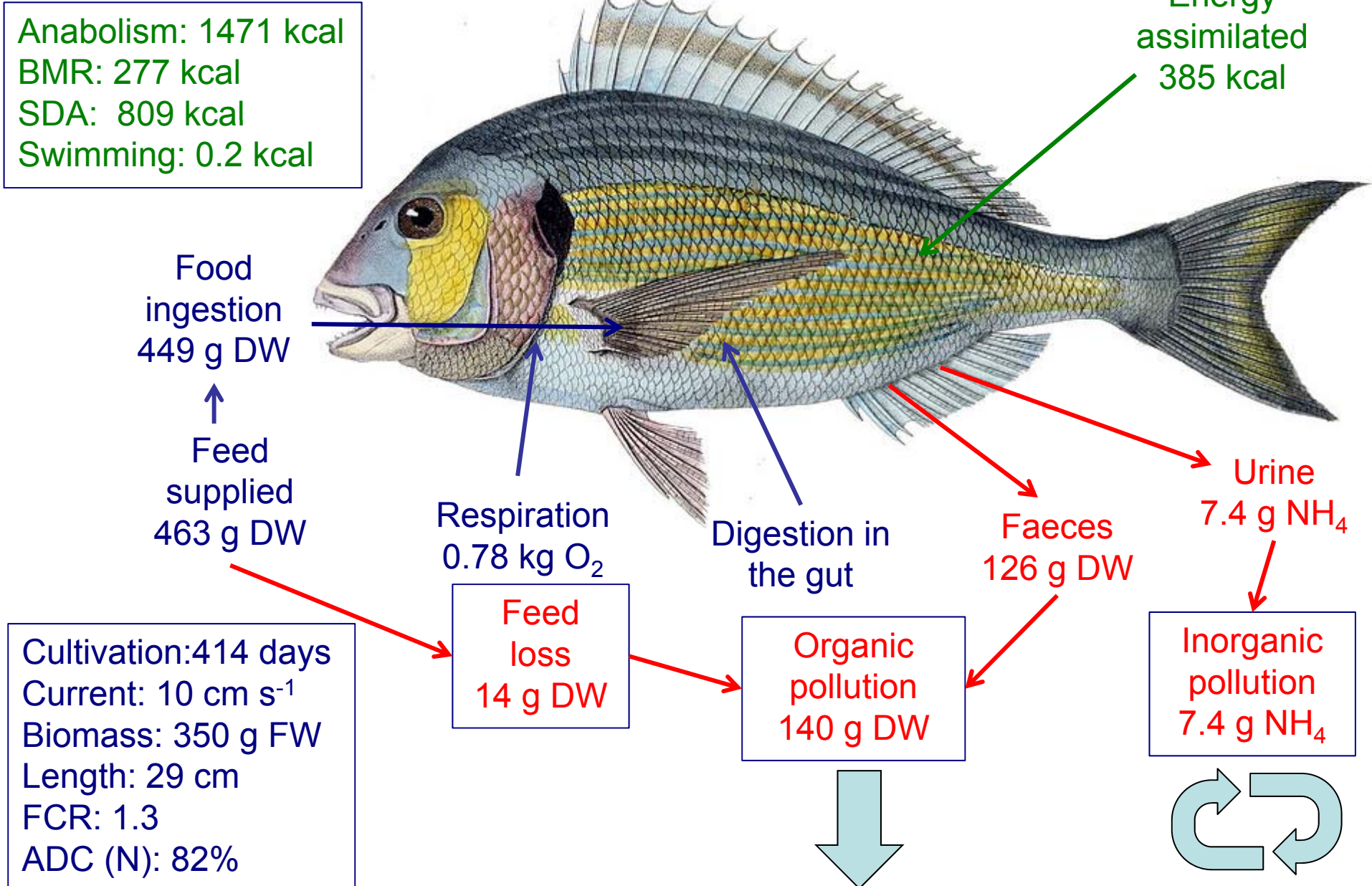
- Larval dispersal;
- Disease;
- Xenobiotics.

Time: 1995/01/03 00:00:00



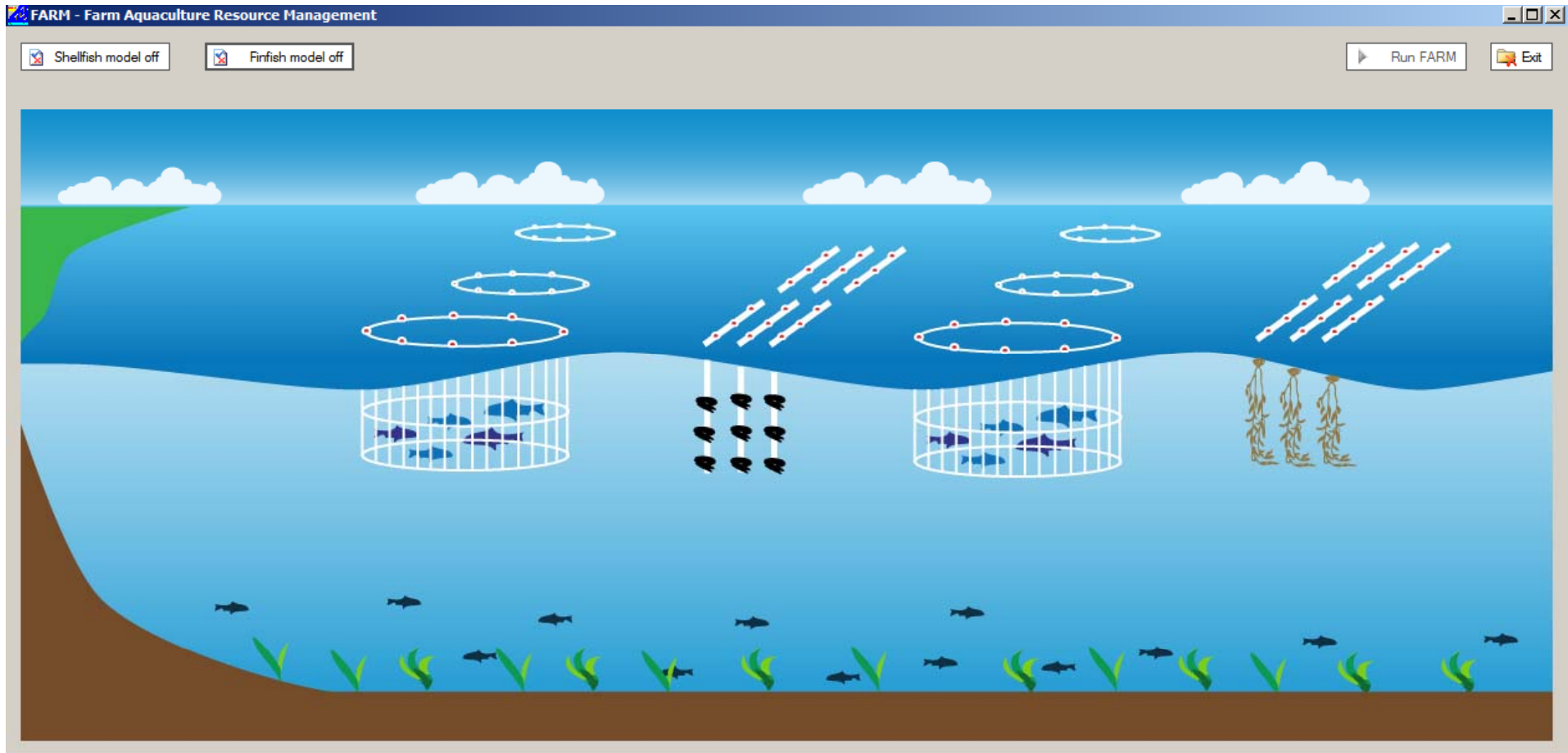
Mass balance for gilthead cultivation

Weight: 350 g, AquaFish model



FARM model

Application to Integrated Multi-Trophic Aquaculture (IMTA)

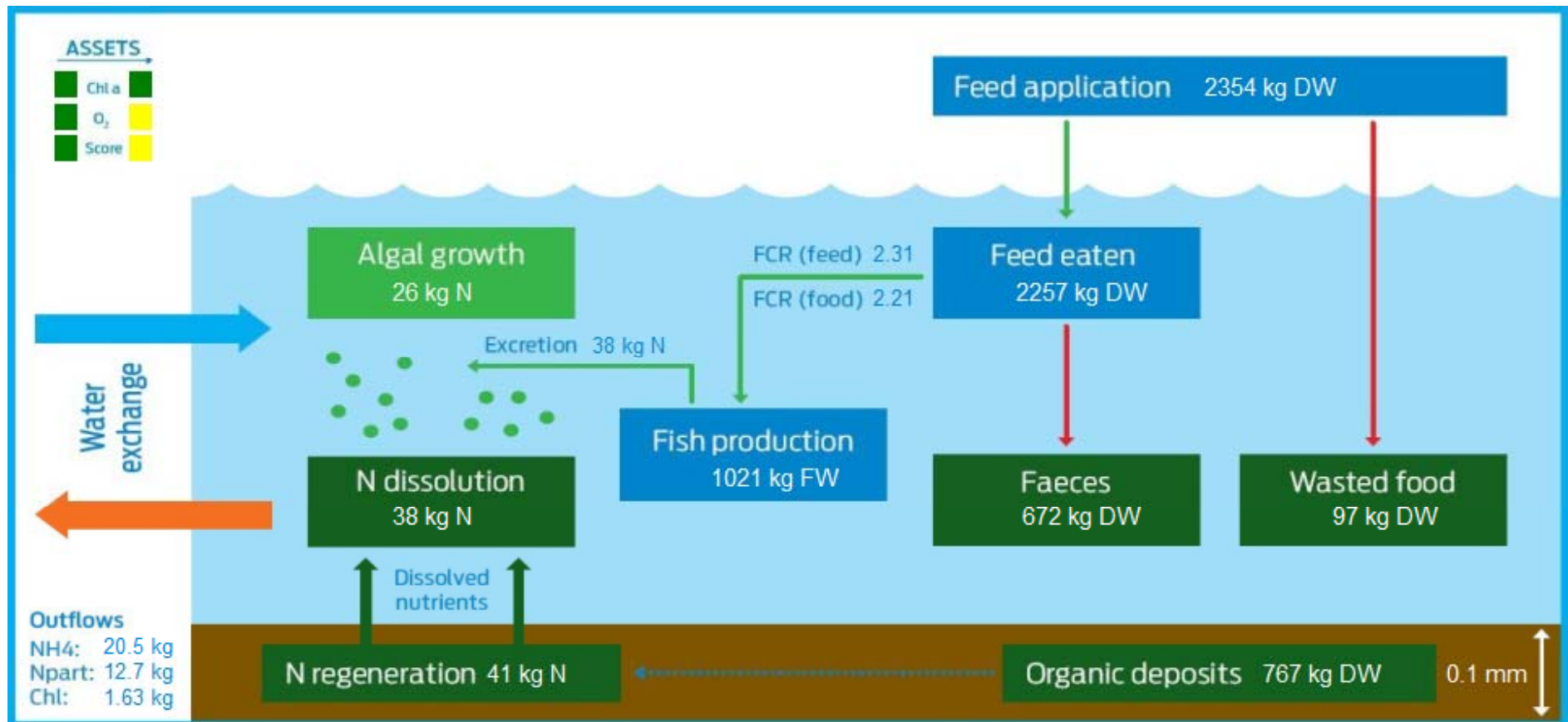


Use of the FARM model for shellfish or finfish monoculture, and IMTA.

Ferreira et al., 2012. Cultivation of gilthead bream in monoculture and integrated multi-trophic aquaculture. Analysis of production and environmental effects by means of the FARM model. *Aquaculture* 358-359, p. 23-34.

Gilthead monoculture in ponds

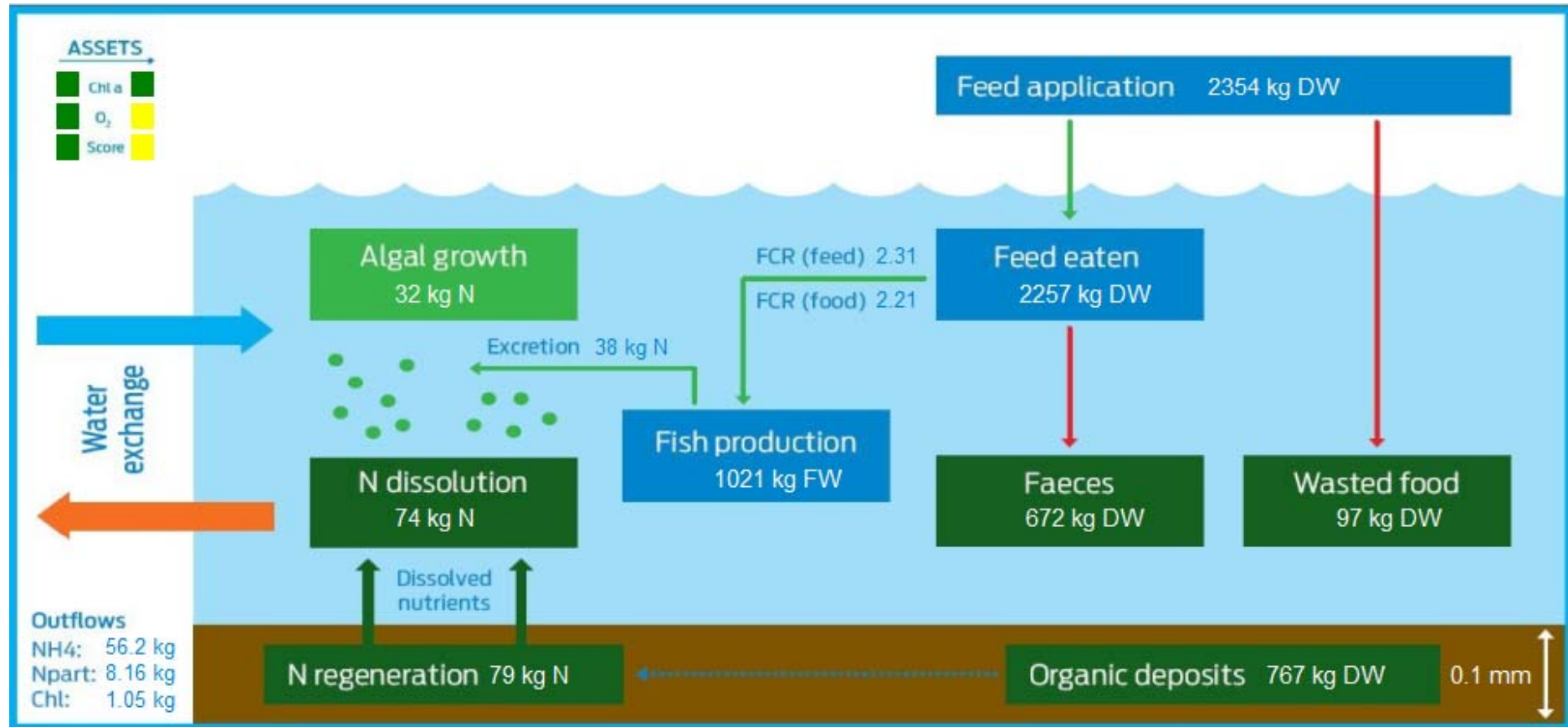
FORWARD & COEXIST projects, SE Portugal



Cultivation for 400 days, 0.5 fish m⁻². Production of about one ton of fish, but with a substantial cost in environmental externalities.

IMTA of gilthead and Pacific oyster in ponds

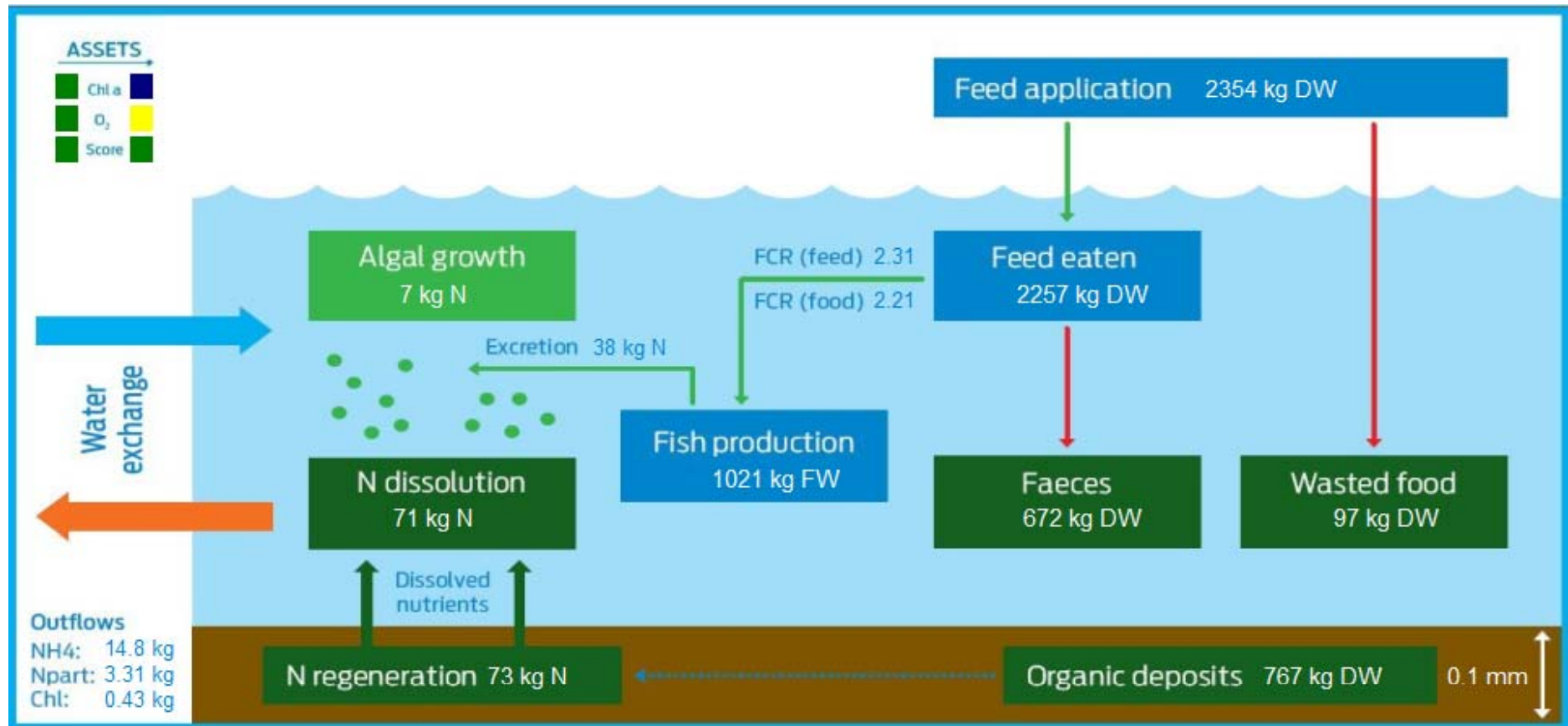
FORWARD & COEXIST projects, SE Portugal



Addition of Pacific oysters in the ponds, at a low density (5 oysters per m²) provides an extra crop of 1610 kg. Benefits: extra income (8,000 USD), less chlorophyll emissions (but more DIN), no change to ASSETS score, PEQ: 6 y-1.

IMTA of gilthead, Pacific oyster, and *Ulva* in ponds

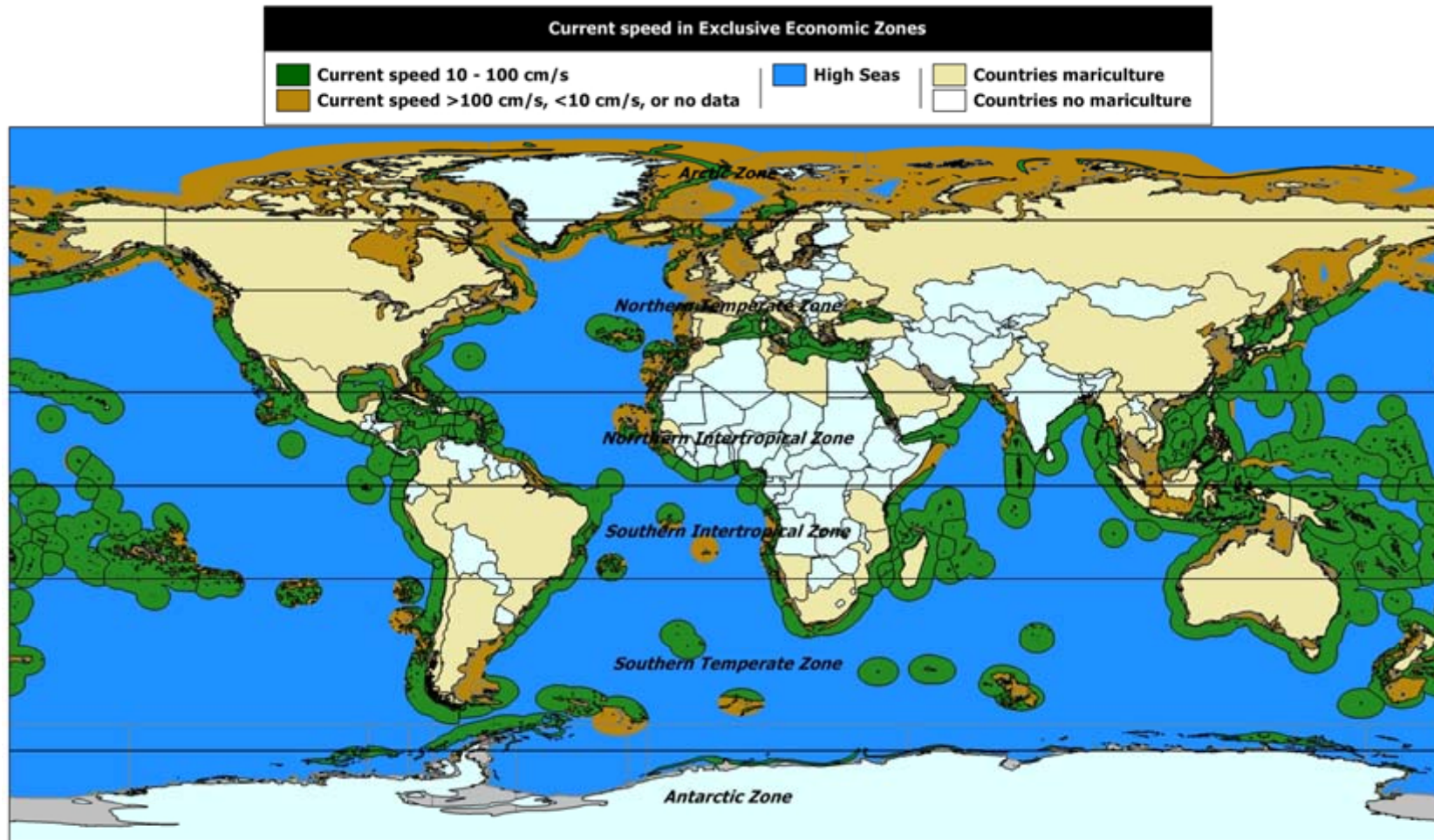
FORWARD & COEXIST projects, SE Portugal



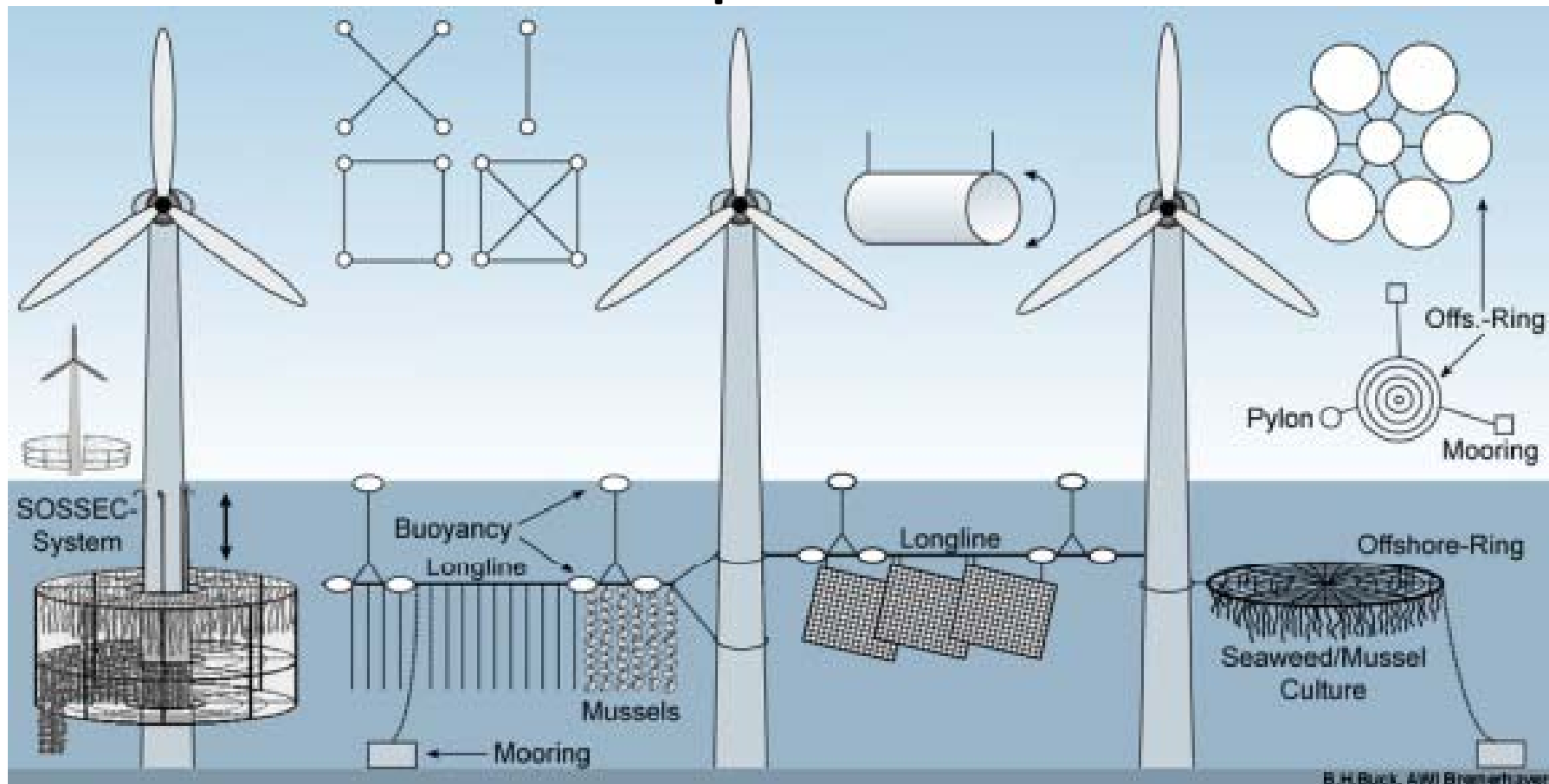
Addition of seaweed in the ponds, at a low density (3 plants per m²) provides an extra crop of 1500 kg (102 kg C). Benefits: extra income, marked reduction in chlorophyll and DIN emissions, better ASSETS score, 31 PEQ.

Offshore aquaculture

Current speeds: 0.1-1 m s⁻¹, suitable depth range for cages and longlines
123 countries with at least 100 km² that meet these criteria: 10⁶ - 10⁷ ton y⁻¹

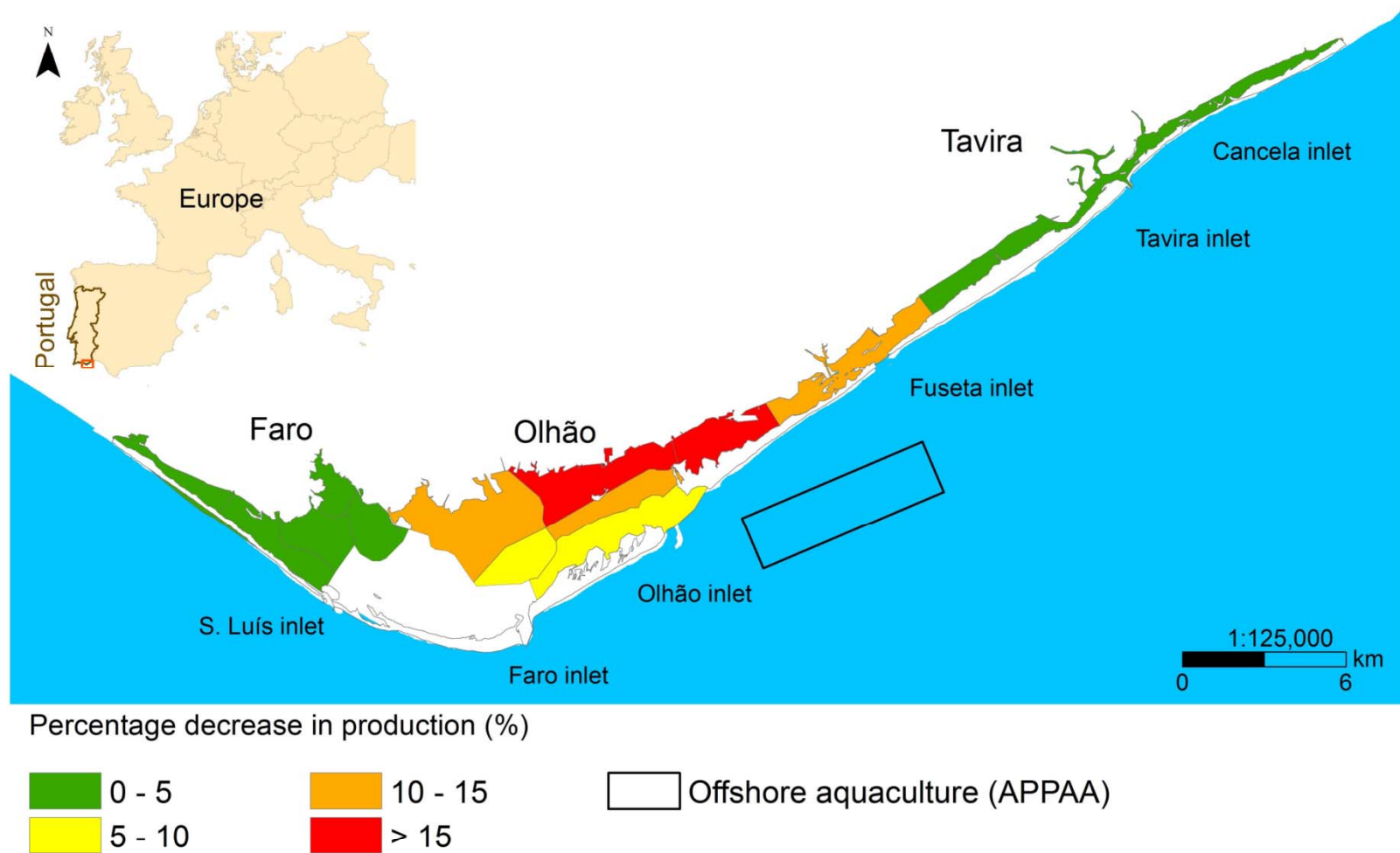


Combination of offshore windfarms and aquaculture



Potential use of wind turbines and enclosed space for cultivating finfish, shellfish, and seaweeds

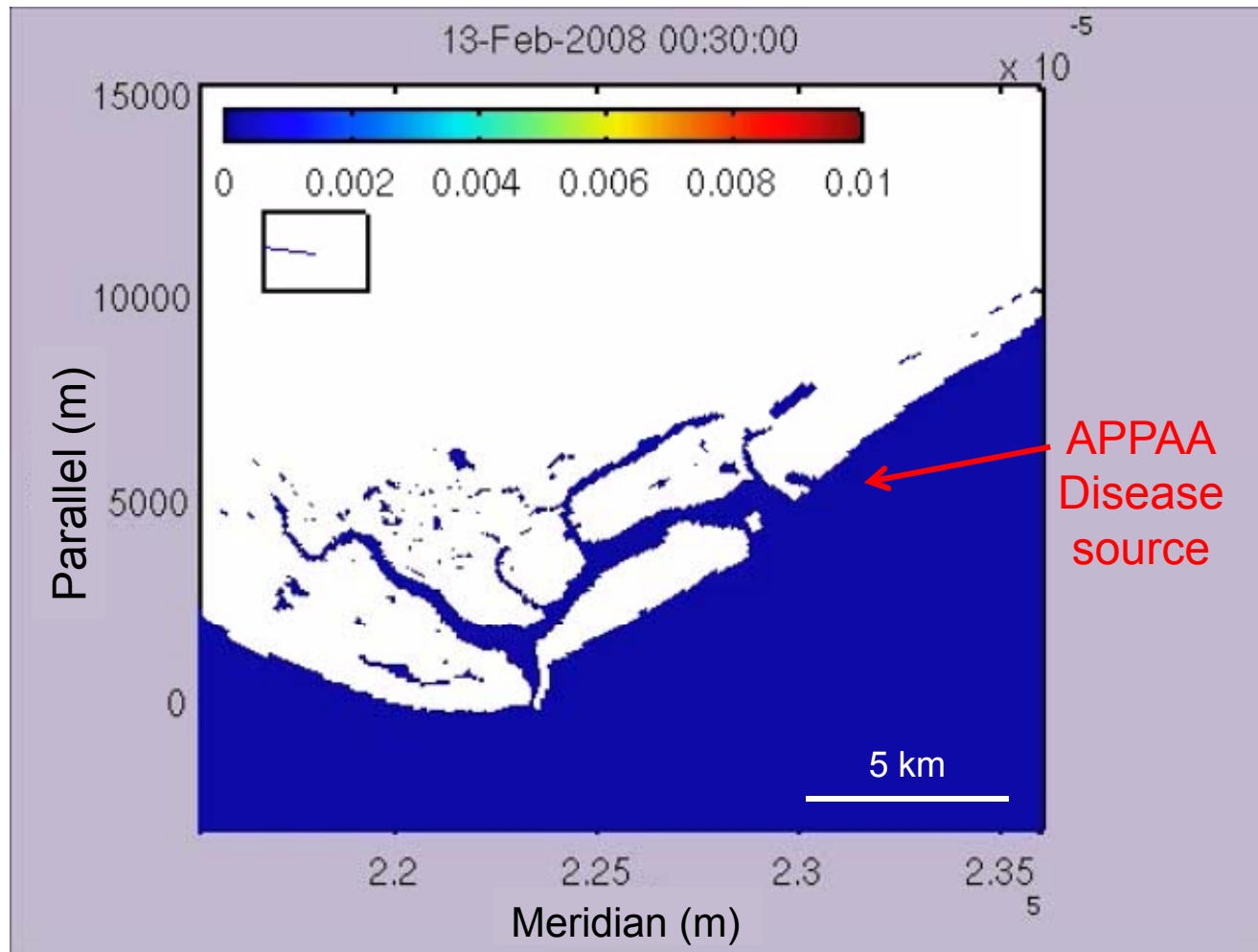
EcoWin2000 - Simulated change in clam harvest due to offshore aquaculture of mussels



An annual loss of 120 t of clams (1.2 million €) is offset by 13,000 t of mussels

Virus Particle tracking:

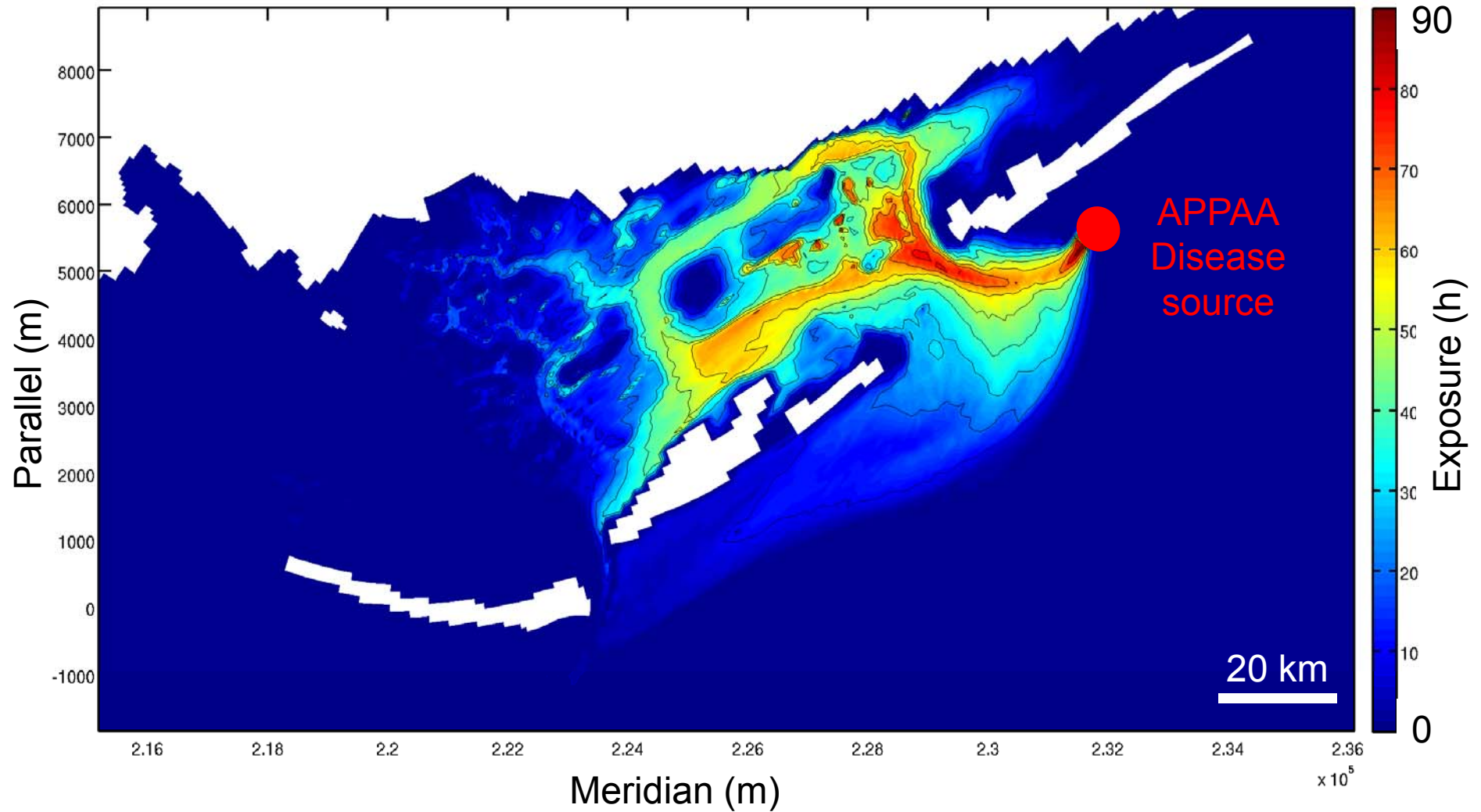
Ratio between concentrations at XYZ and emission concentration



- Disease source: APPAA
- Virus concentration: Up to $2 \times 10^6 \text{ ml}^{-1}$
- Forcing functions wind and tide
- No decay
- 6 day model run
- Release in mid-water layer

Background virus release the first 2 days, high release on days 3,4 and 5, then a reduction by a factor of a hundred on the last day.

Virus exposure



Number of hours of exposure to 0.5% of the shedding concentration as a measure of potential infection.

The revenge of the killer mussels...



Huge mussel fouling in the summer of 2012. Spat from offshore culture?

Conclusões

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- Portugal precisa de mais aquacultura, mas uma boa parte terá que ser desenvolvida nos grandes estuários, e.g. Tejo e Sado;
- A nossa costa ocidental é muito agitada – o cultivo vai ser caro e difícil em termos logísticos. A costa sul é melhor mas há mais conflitos de usos;
- Temos que decidir quais as espécies, quais as zonas, e qual o mercado, senão temos a fábula do bacalhau e da panga;
- Para competir no mercado de peixe, temos que fazer o ‘branding’, a certificação, e definir classes intermédias de produto. E aproveitar a boa imagem do pescado nacional;
- Estamos longe da realidade: é preciso fazer mar, e não só falar mar—não foi assim que chegámos à Índia.

<http://goodclam.org/forwardpt/>

Resilience...

