Seaweed Cultivation: Development & multiple benefits

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Contents

- History, uses and current trends
- Why grow seaweed
- Economic challenges
- Developing cultivation practices in Europe
- How might we manage a future seaweed industry

Seaweed Industry
A long history

First historic record 600AD as a food

Kelp burnt to produce kelp-ash for soda and potash

In the 1700s Scotland was harvesting 400,000 tonnes of seaweed per annum employing 60,000 workers.

Iodine production flourished in mid 1800's with 20 factories in Glasgow alone

Alginate was first isolated by EC Standford in 1893. Decline during 60's-70's, as other sources of alginate were used

SAMS

Seaweed uses

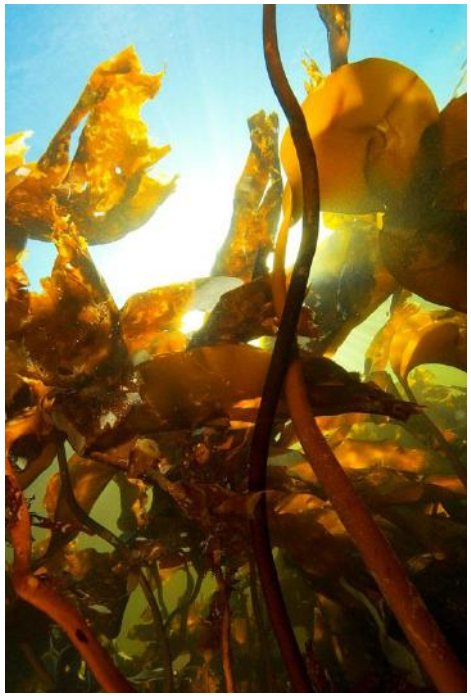
Existing markets for marine bio-based products from macroalgae		
Product type and notes	***Market Targets***	***Overall estimated market***
hydrocolloids agar > €150M carrageenen agarose	Food, cosmetics, pharma, research products	*ca* $2bn[1]; *ca* $4.5bn[2]
Antioxidants and other functional ingredients	cosmetics & personal care	>$700m[1]; >$20bn[2]

[1] = ingredients
[2] = direct use for food

Table modified from Lloyd-Evans, *Chemistry & Industry*: **2**, 2010
http://www.soci.org/chemistry-and-industry/cni-data/2010/2/out-of-the-blue

Case studies: **Bioplastics**

Car of the future!



TOYOTA

‘Kelp Car’

“…..ultralight, superefficient plug-in hybrid with a bioplastic body made of seaweed that could be in showrooms within 15 years….”

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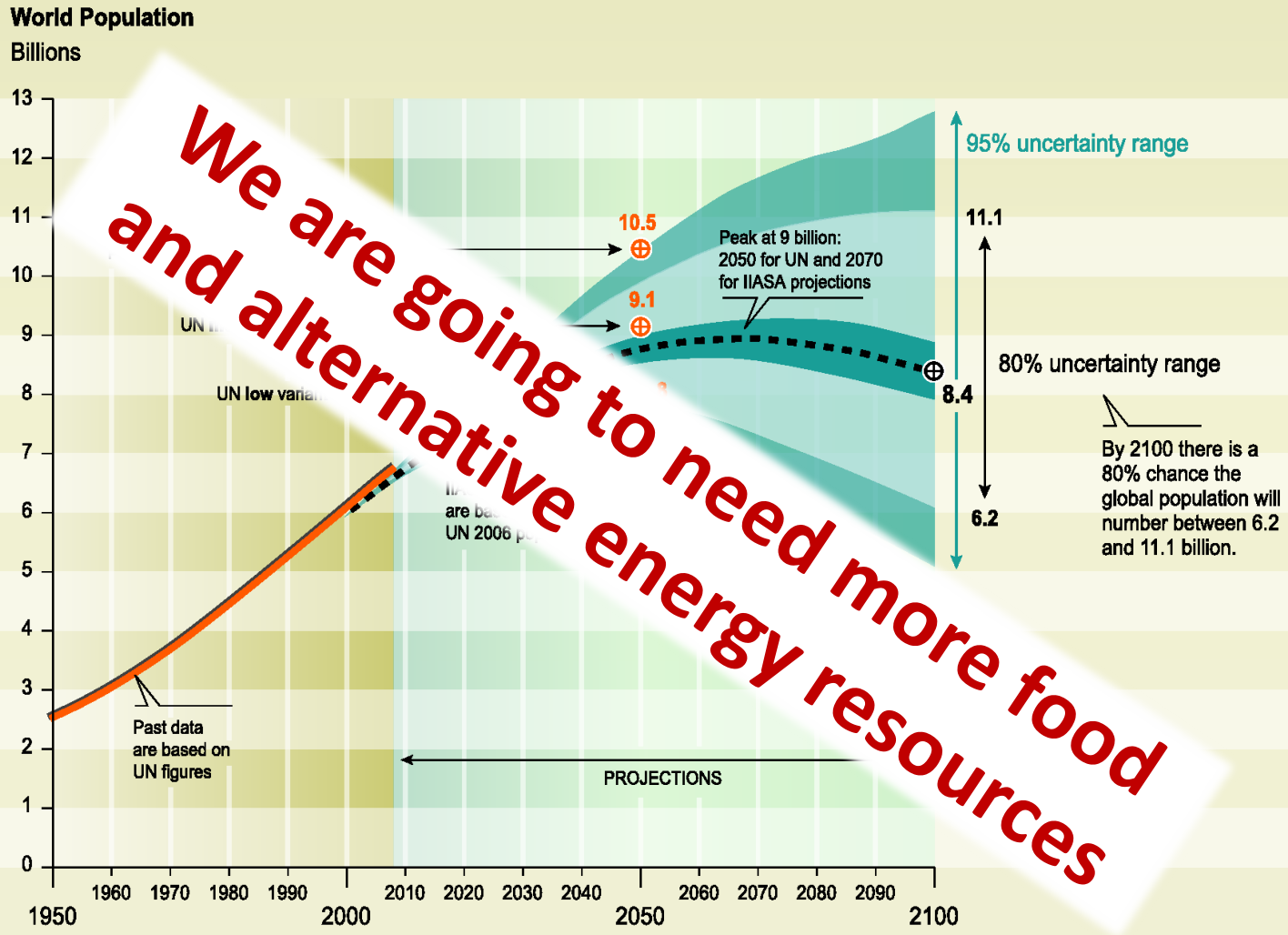
World population projections

IIASA probabilistic projections compared to UN projections



We are going to need more food and alternative energy resources

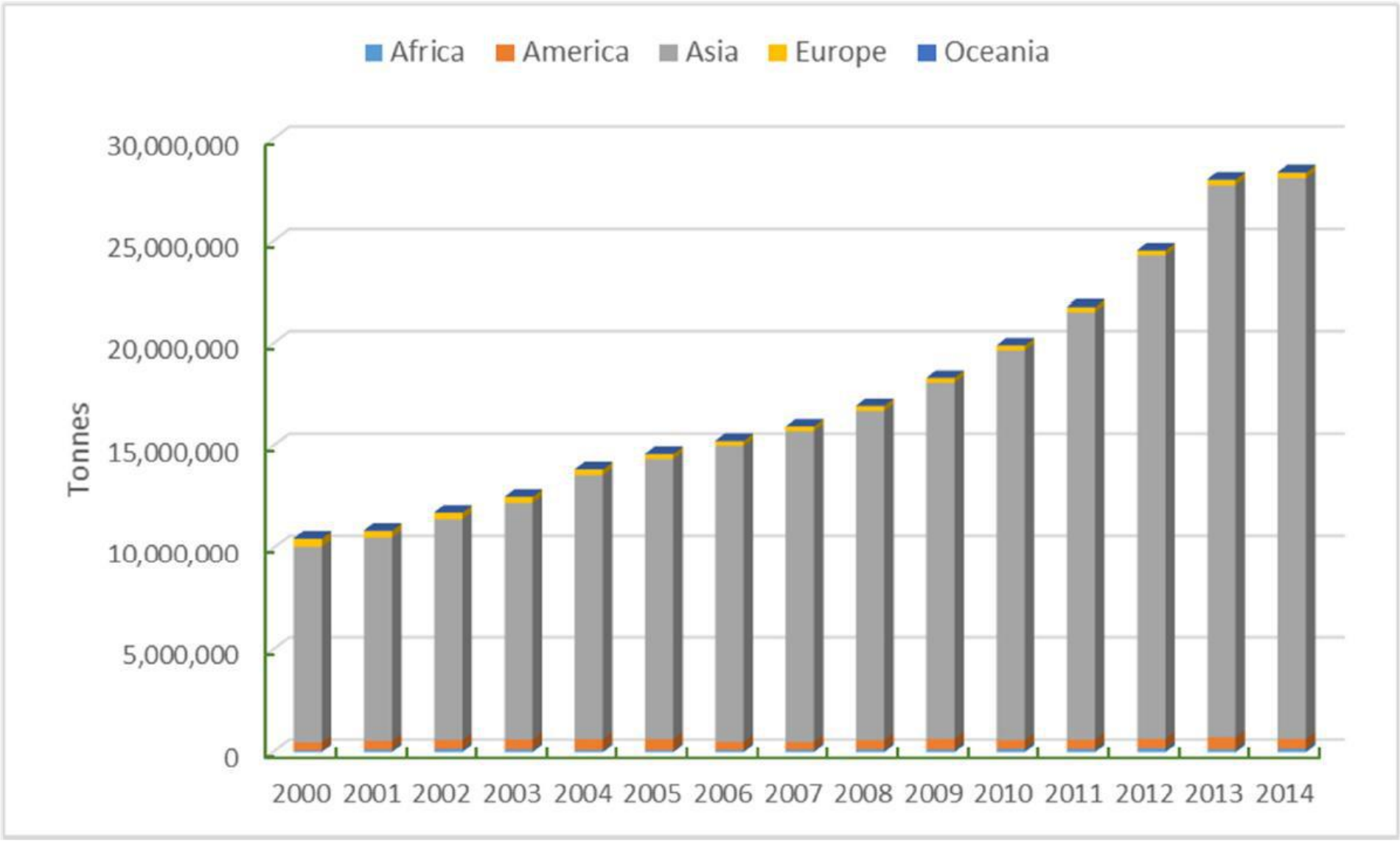
Note: the UN Population Division studies fertility-evolution scenarios to produce high, medium and low variant figures, whereas the IIASA bases its calculations on assumptions for fertility, mortality and migration (the latter only affecting regional projections).

Sources: Lutz W., Sanderson W. and Scherbov S., *2007 Probabilistic World Population Projections*, International Institute for Applied Systems Analysis (IIASA); UN Population Division, *World Population Prospects: The 2008 Revision*.

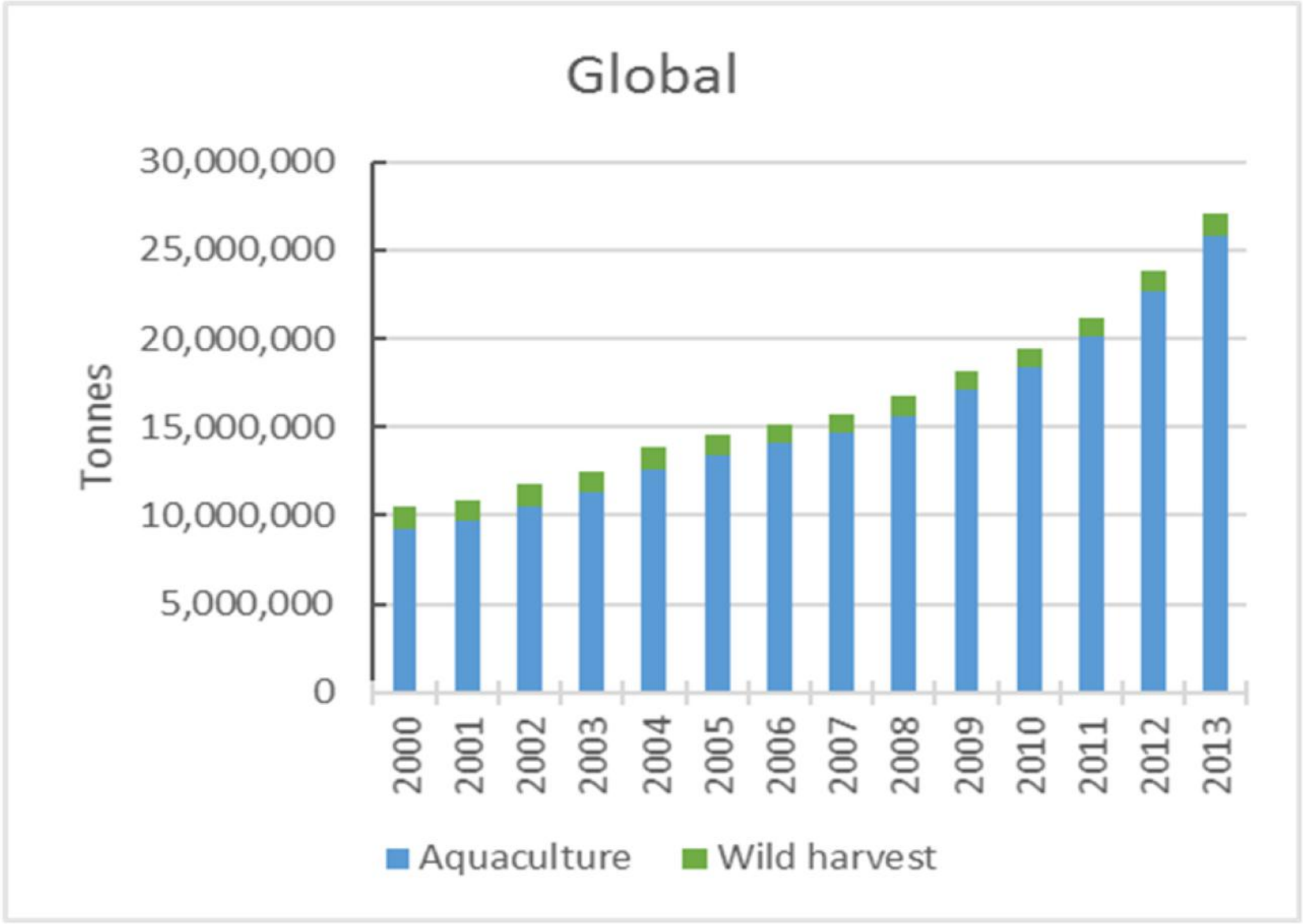
Large scale cultivation is established in Asia (for 60yrs)

Sangou Bay, China: the cultivation of seaweed stretches for more than 10km out to sea.

China grows 9 million tonnes *L. japonica* grown annually making it the largest single species aquaculture crop in the world



Cefas Seaweed industry report 2016



Cefas Seaweed industry report 2016

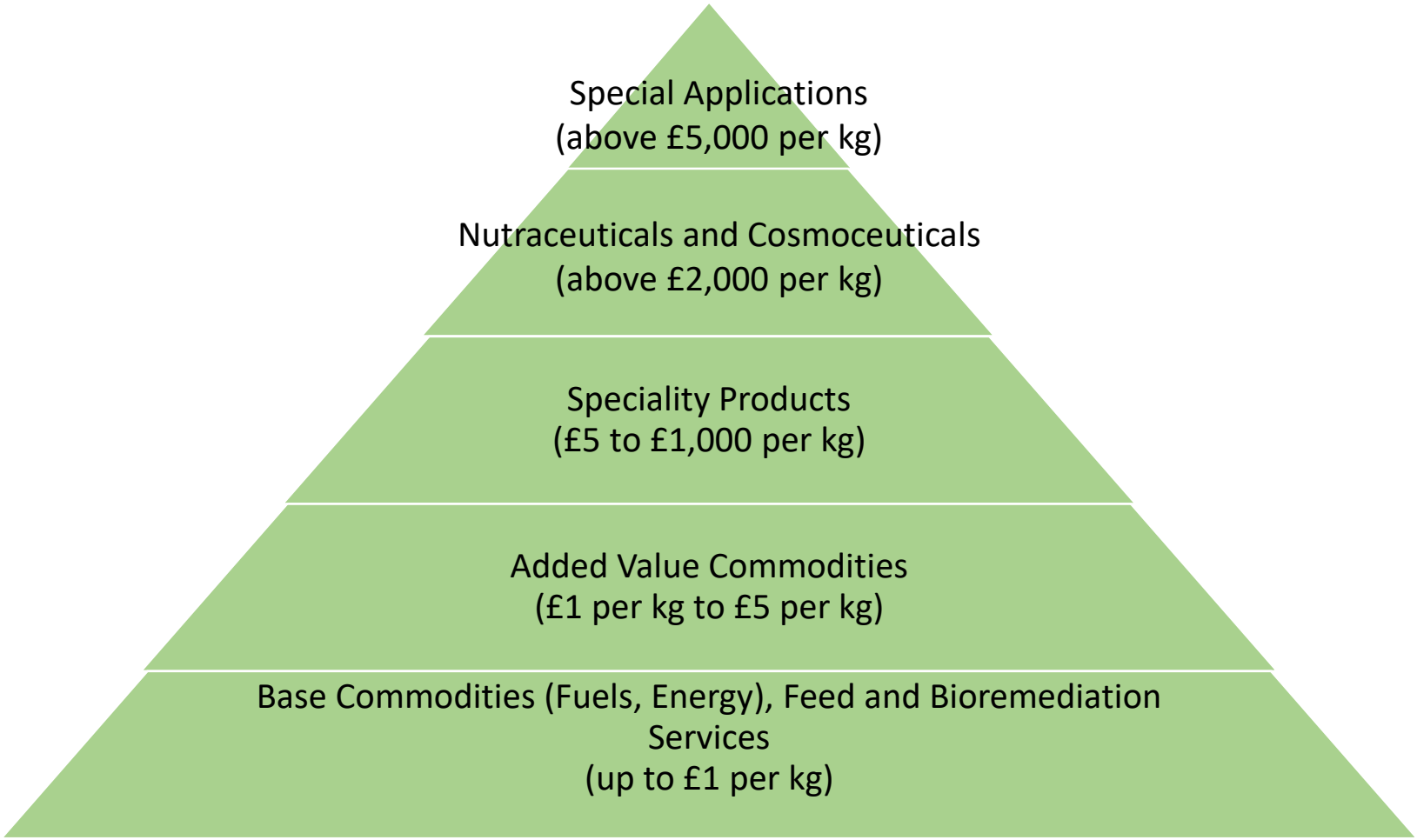
Why not wild harvest?

This shallow water vulnerable resource is essential habitat, home to a wide biodiversity of flora and fauna and nursery grounds for many important species.

Norway harvests about 170kt but there are questions over environmental impact and sustainability of this supply.

Little control over product quality (by-catch, rubbish, age structure, and composition)

In terms of making a contribution to commodity products: wild harvest is unsustainable and insignificant



Value Pyramid for Algal Derived Products (modified from Subitec Value Pyramid for Algae Product Markets in Bruton et al, 2009)

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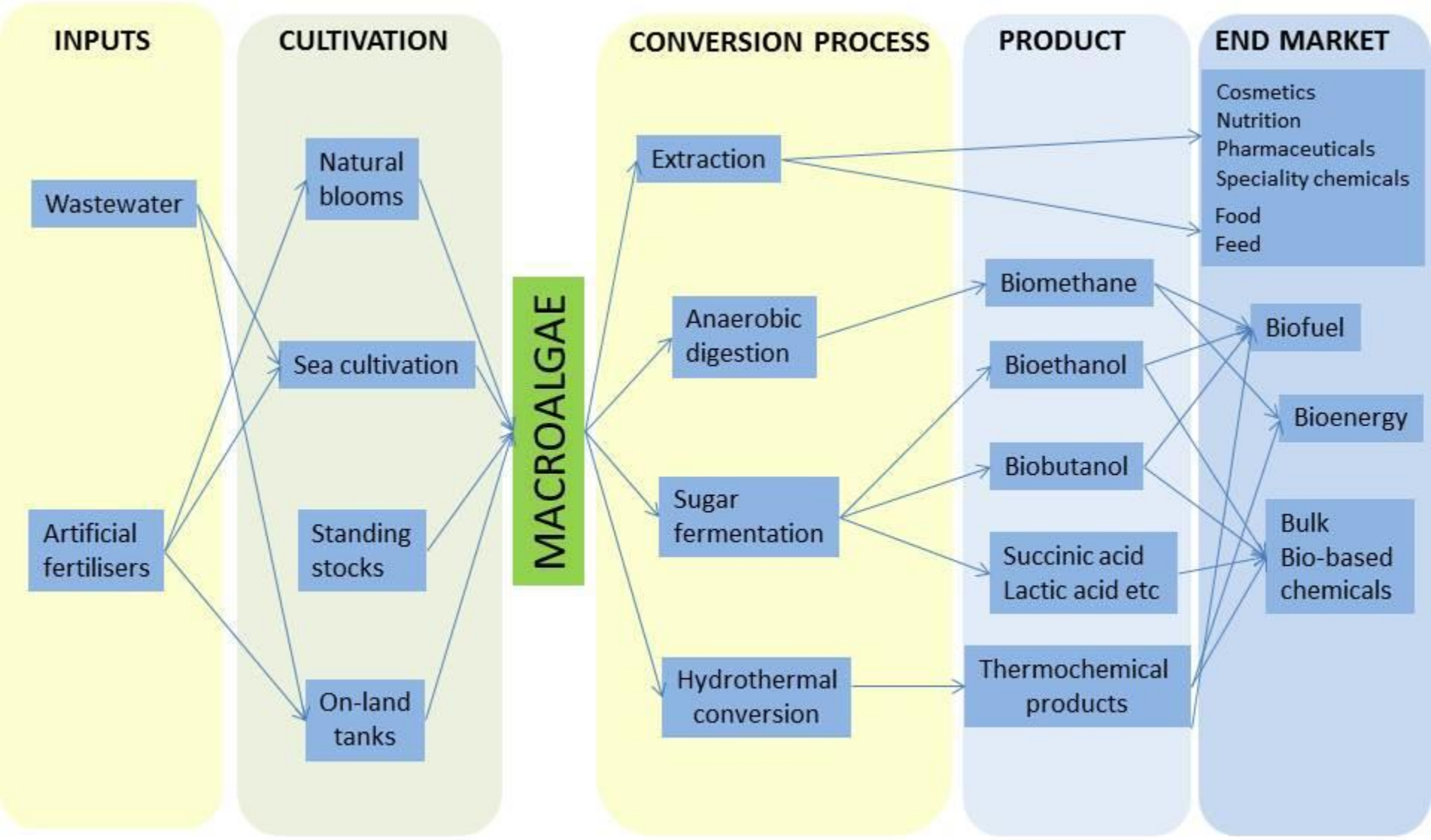

Figure adapted from the Report for the Algal Bioenergy Special Interest Group: *Research needs in ecosystem services to support algal biofuels, bioenergy and commodity chemicals production in the UK*, February 2012

How is seaweed cultivation developing in Europe

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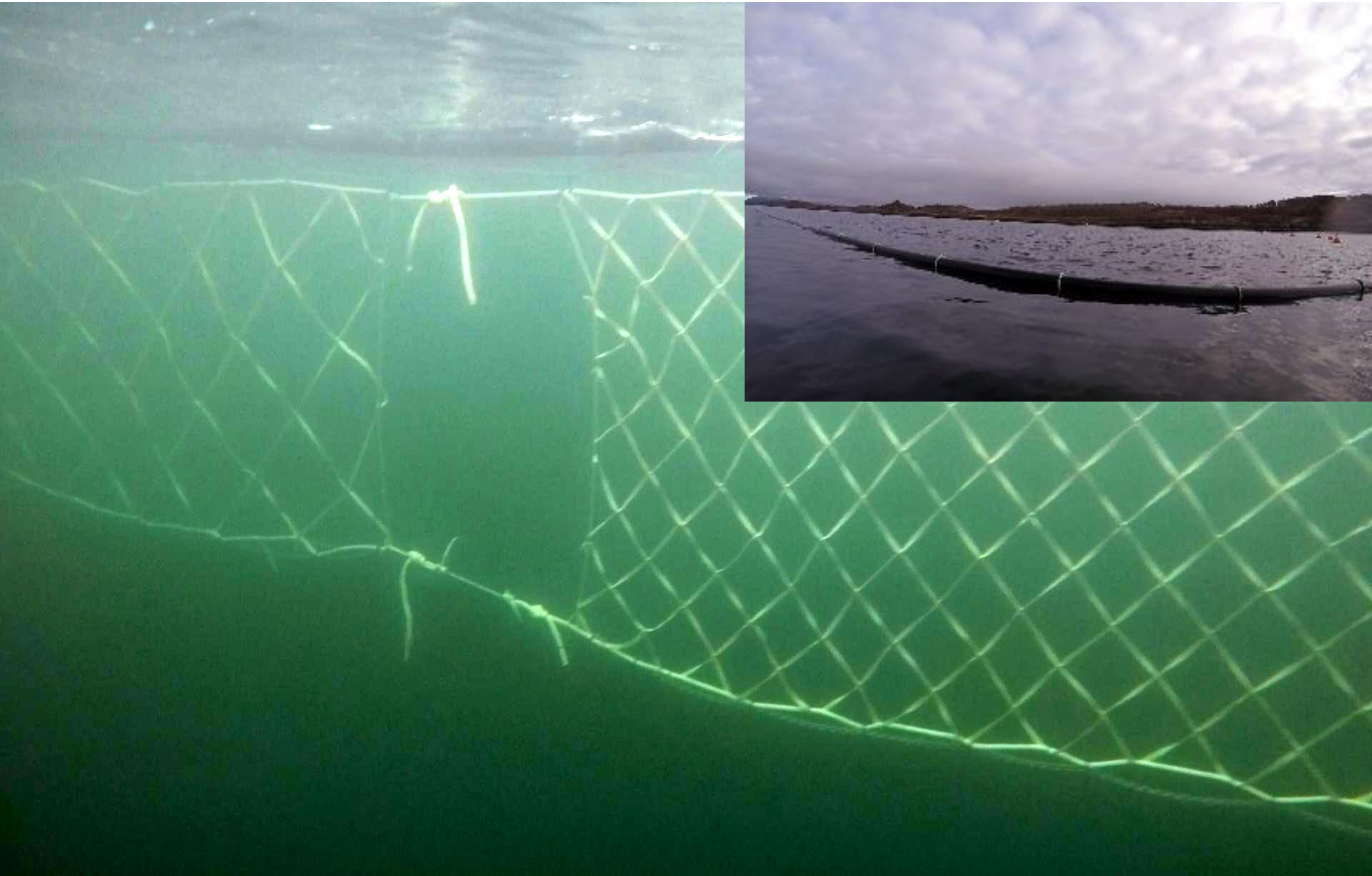
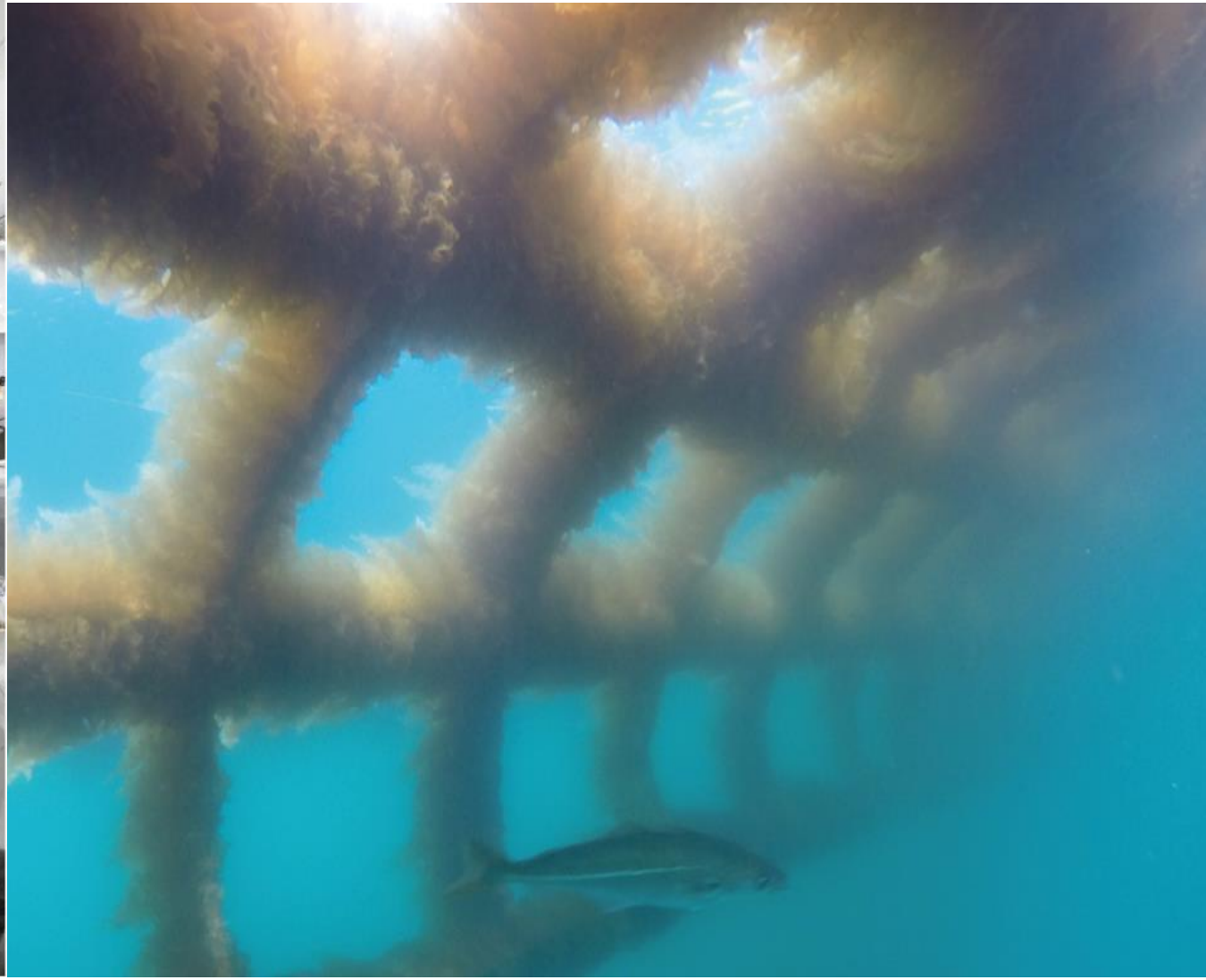
The development seaweed farms in the UK

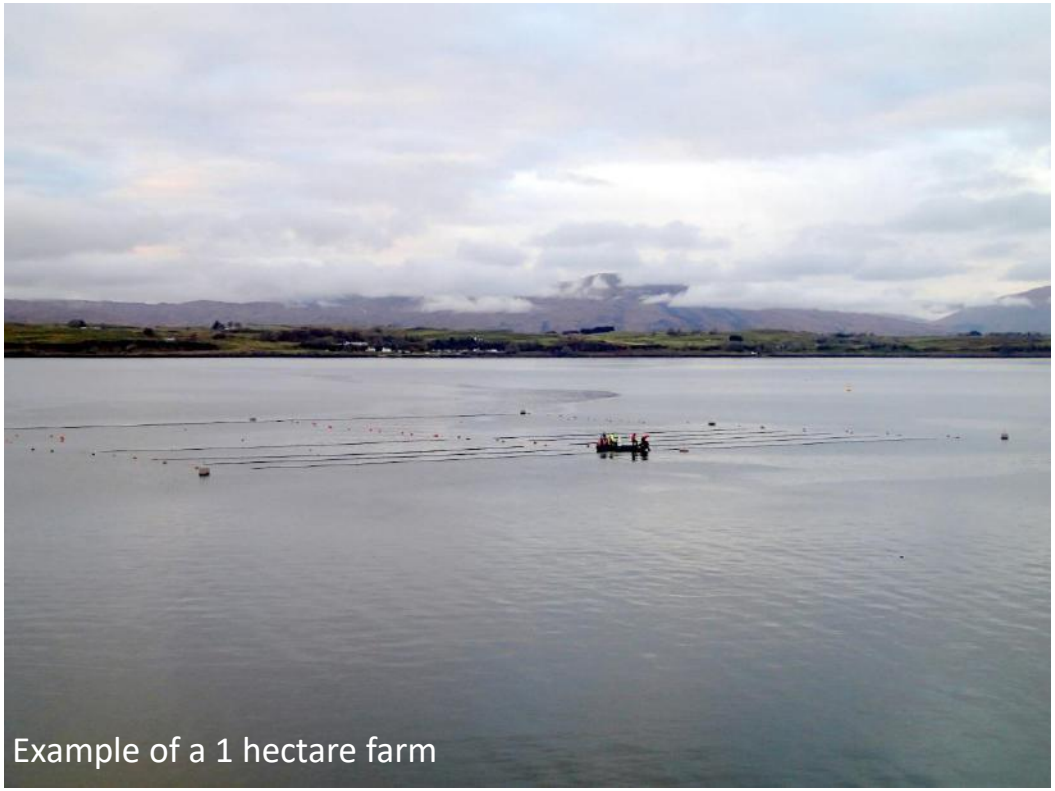


The development seaweed farms in the UK



The development seaweed farms in the UK

What are the space requirements?


Example of a 1 hectare farm

Source	Million hectares
Soybean	1.48
Corn	0.15
Sugarcane	0.07

http://biofuel.org.uk/land-use.html

Renewable Transport Fuels Obligation (10% of transport fuels from renewable resources by 2020). Less than 7% from agricultural crops.

This will require approx. 0.69 million tonnes of biofuel by 2020*

Based on **current** productivity this will require 3.4 million hectares of cultivation area. Using a biorefinery process this biomass will produce:

- 439,000 tonnes of protein rich fish feed
- 1600 tonnes of phosphorus in the form of liquid fertiliser
- Fix 11,000 tones of Nitrogen

* Estimate is based onhttps://www.gov.uk/government/uploads/system/uploads/attachment_data/file/572976/rtfo-consultation-cost-benefit-analysis.PDF. Seghetta et al 20016. Life cycle assessment of macroalgal biorefinery for the production of ethanol, proteins and fertilizers e A step towards a regenerative bioeconomy.

Environmental considerations

Inputs

Absorption of light

Absorption of nutrients

Absorption of kinetic energy

Addition of juvenile seaweed

Addition of artificial material

Drivers of change

Outputs

Creation of noise

Realise of Particulate Organic Matter

Realise of Dissolved Organic Matter

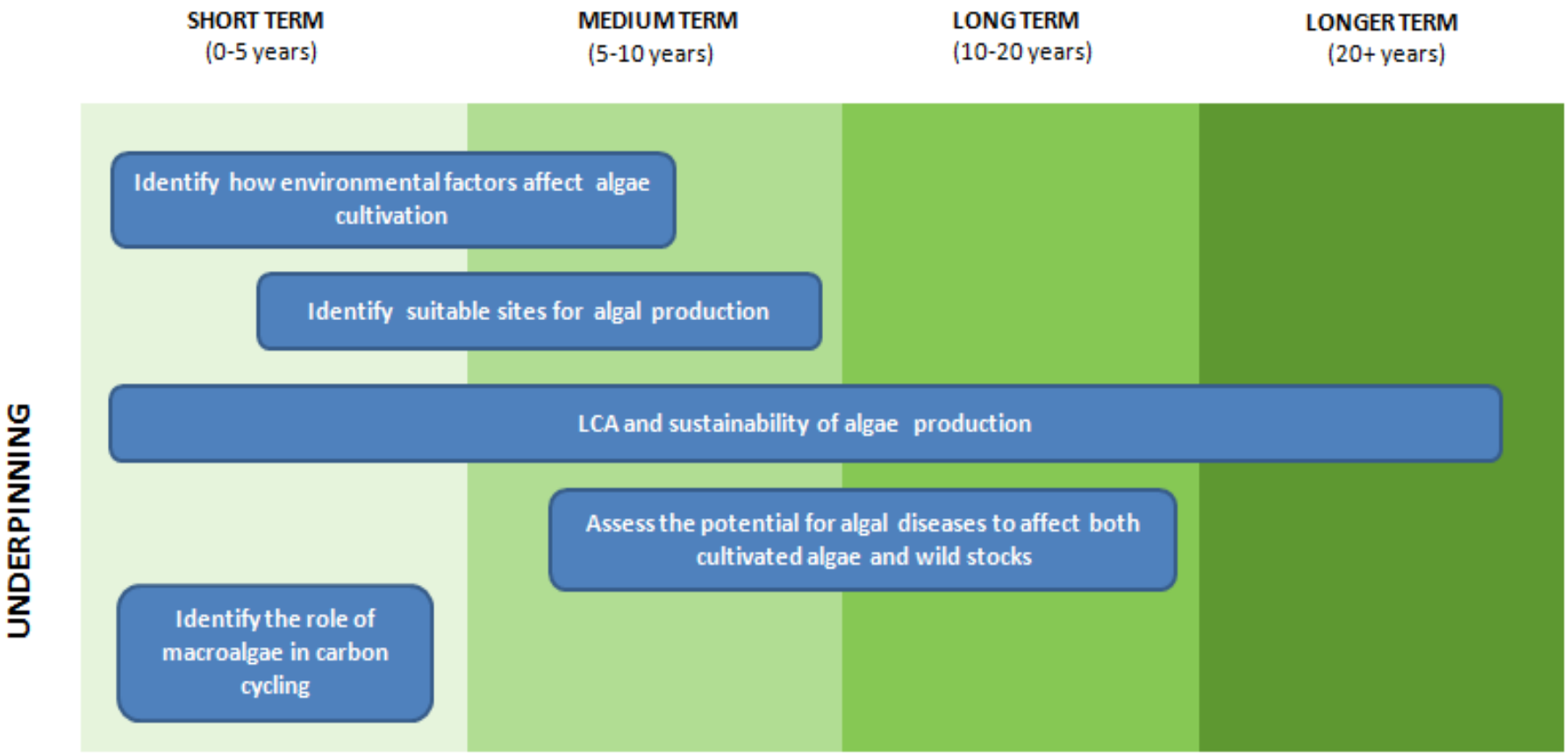
Dissolved Inorganic Matter

Disease, parasites and non-native species

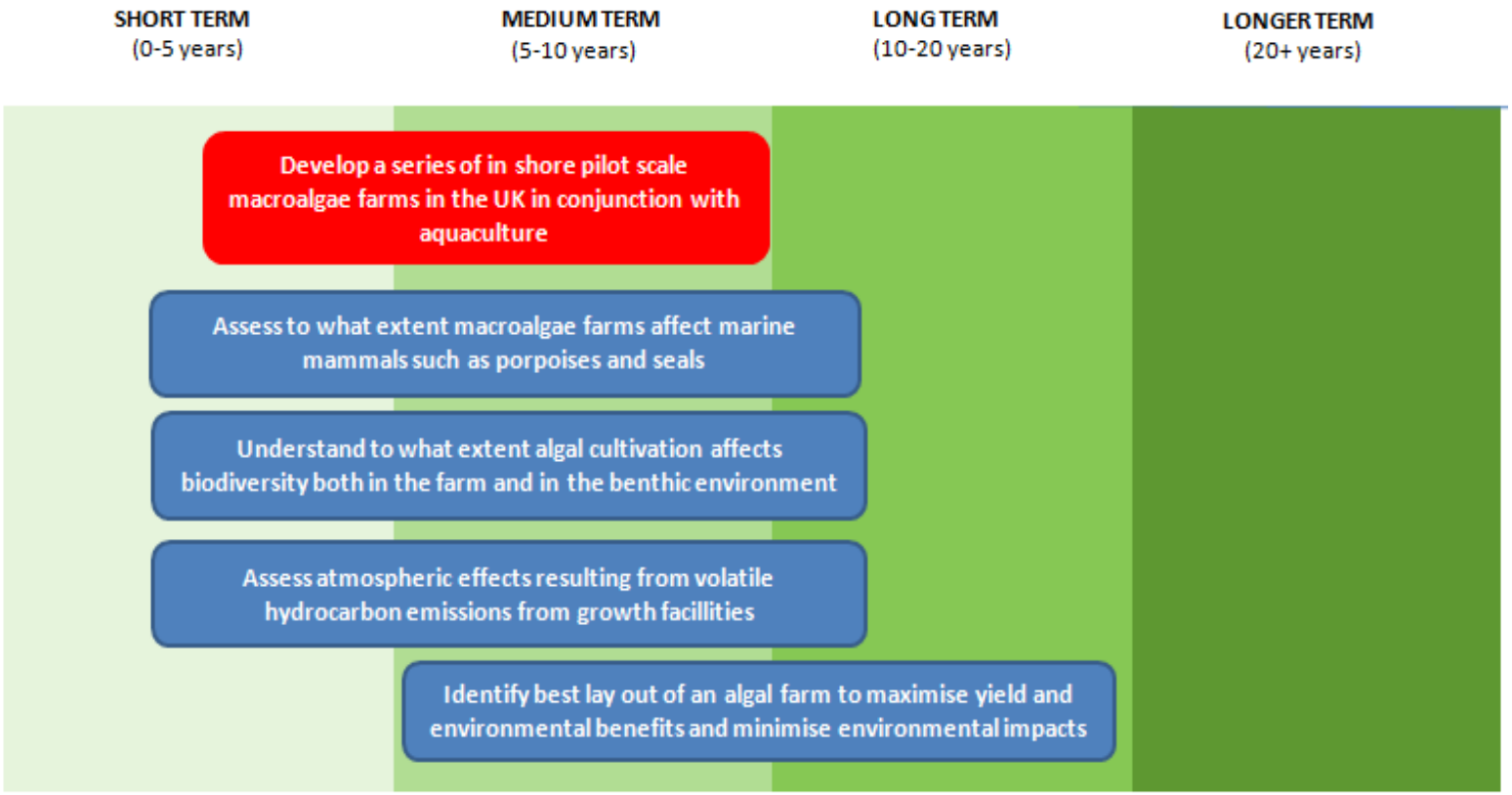
Release of reproductive material

Artificial habitat creation

Underpinning Research Needs in Ecosystem Services



Research Needs for Assessing Effects on Ecosystem Services from Near Shore Cultivation



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- Additional work is needed to create a profitable industry.
- There is a need to clearly articulate the benefits of this type of aquaculture whilst ensuring management is proportionate to the risks.

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Roinn Cumarsáide, Fuinnimh agus Acmhainní Nádúrtha

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