OCEAN RAINFOREST

SUSTAINABLE NORDIC SEAWEED

Seaweed cultivation – company experiences from the Faroe Islands

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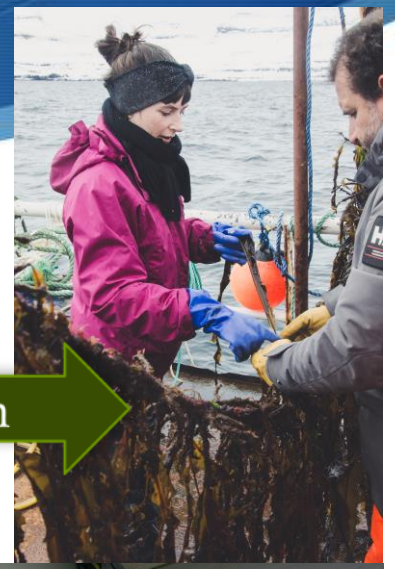
SIG Seaweed 5 Conference

Trondheim, November 27, 2019

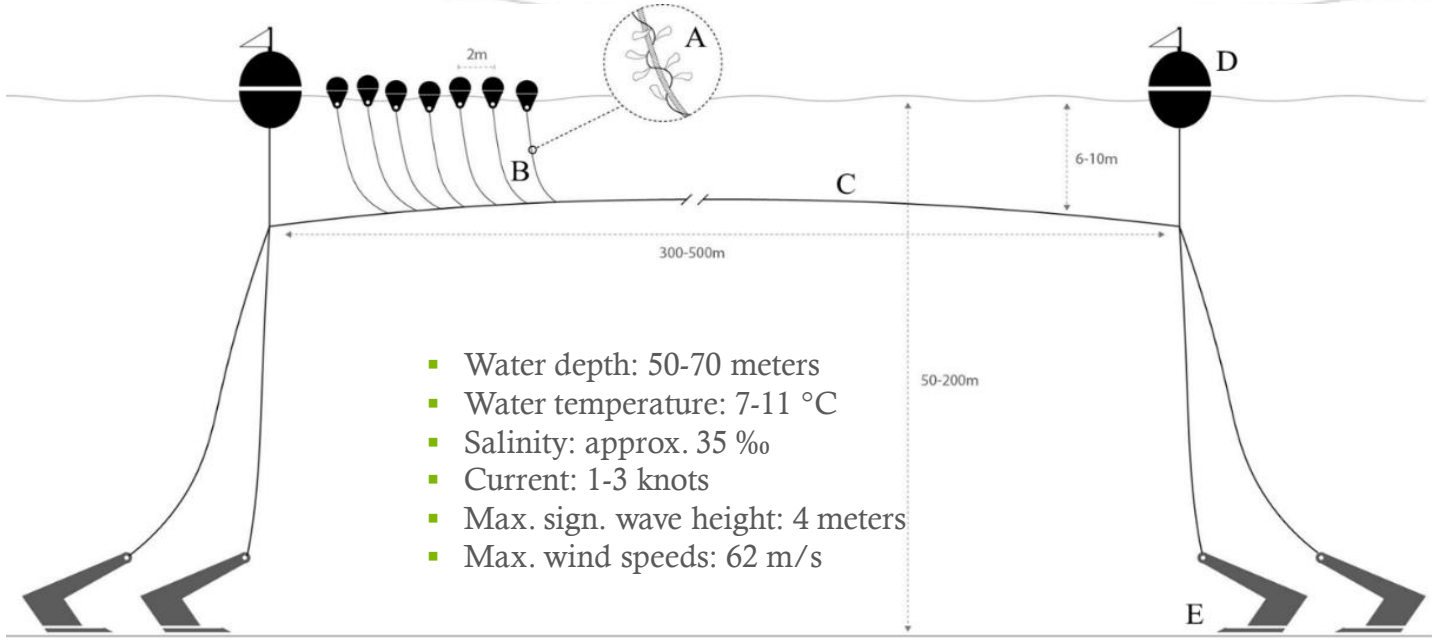
The value chain of Ocean Rainforest



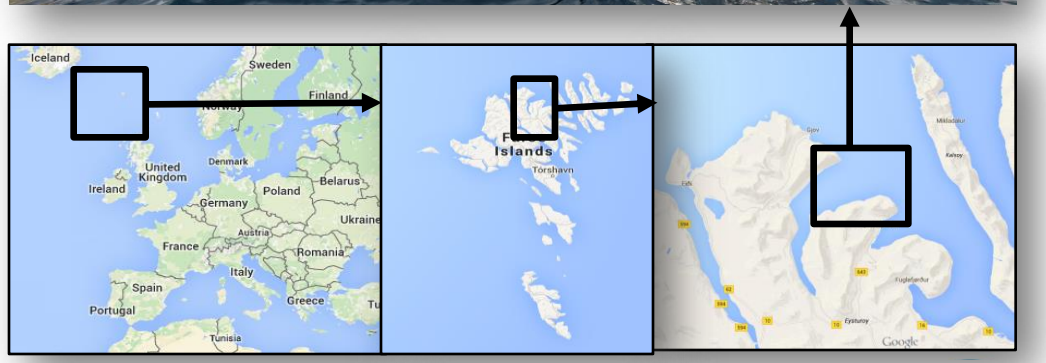
Seeding → Deployment → Growth at sea, maintenance and inspection

Harvesting → Storage Stable Intermediate → Ensilage → Frozen → Dried, milled and sieved → B2B

The MacroAlgal Cultivation Rig



- Water depth: 50-70 meters
- Water temperature: 7-11 °C
- Salinity: approx. 35 ‰
- Current: 1-3 knots
- Max. sign. wave height: 4 meters
- Max. wind speeds: 62 m/s



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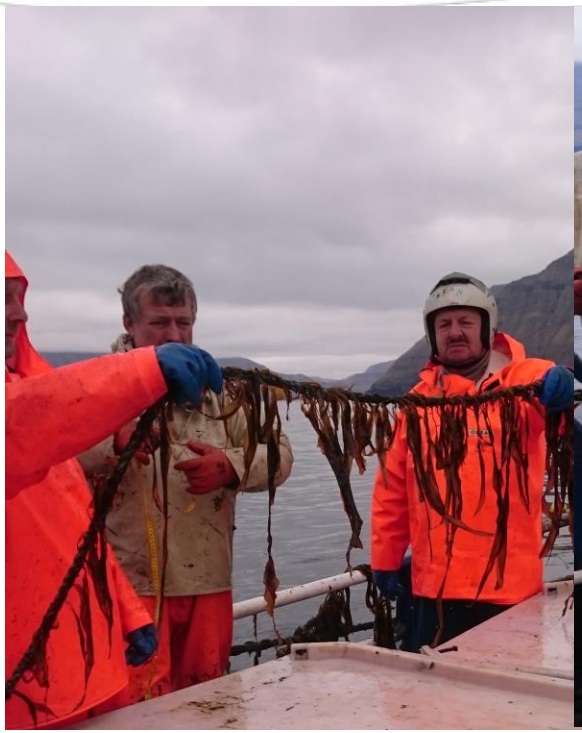
Harvest method and growth monitoring



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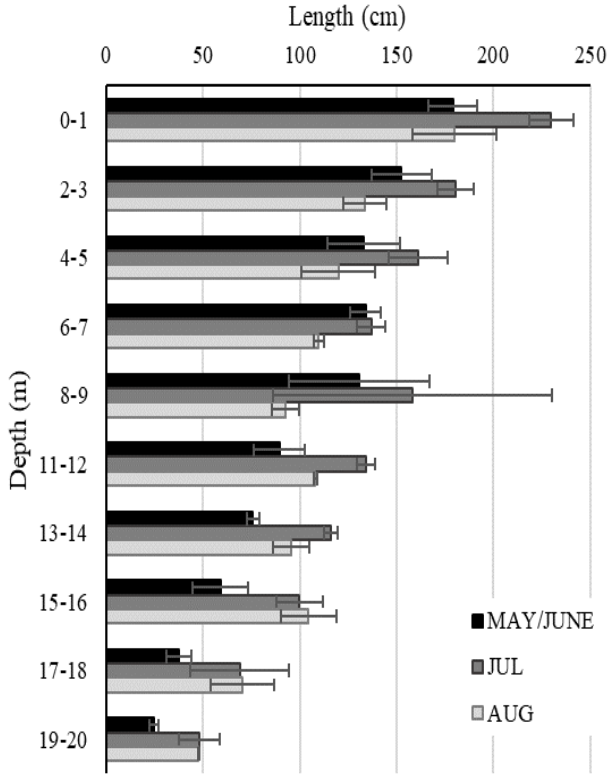
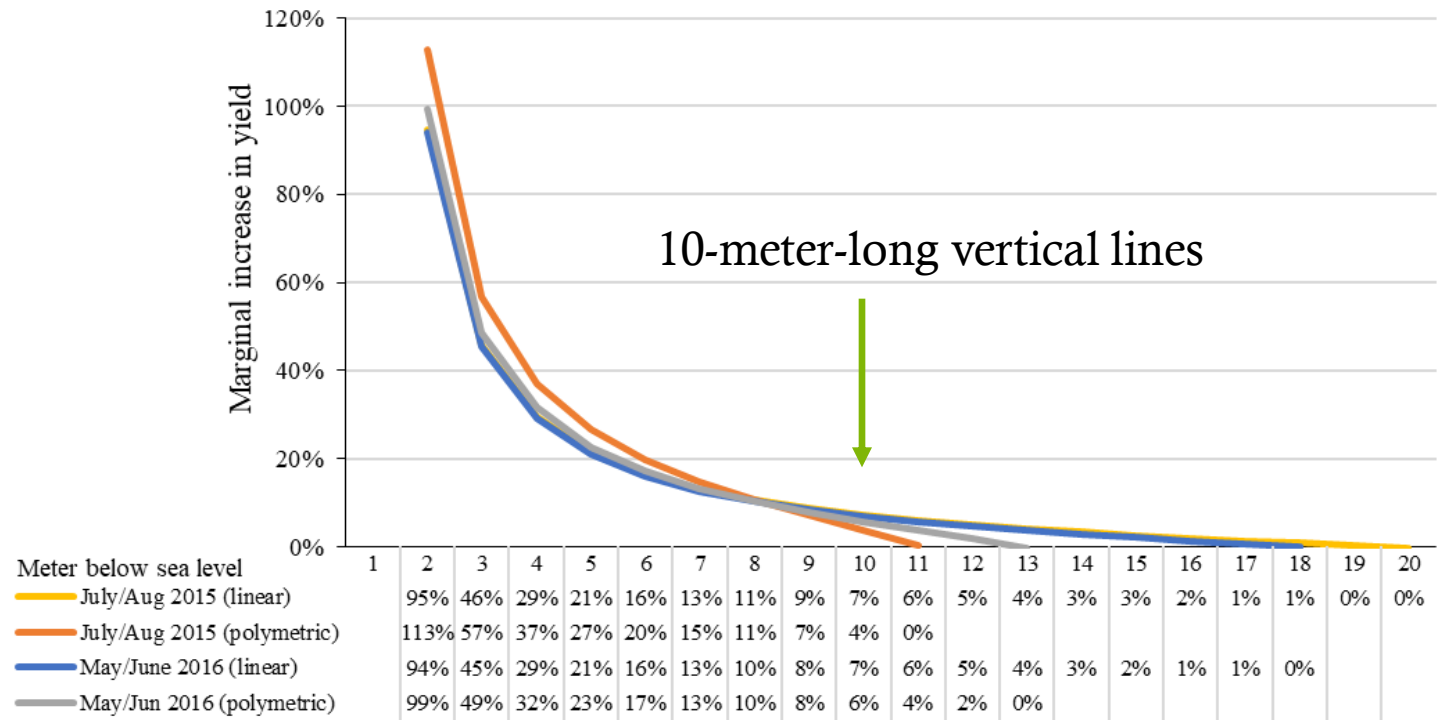
Length and yield increase with depths

Saccharina latissima, exposed site





Meter below sea level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
July/Aug 2015 (linear)		95%	46%	29%	21%	16%	13%	11%	9%	7%	6%	5%	4%	3%	3%	2%	1%	1%	0%	0%
July/Aug 2015 (polymetric)		113%	57%	37%	27%	20%	15%	11%	7%	4%	0%									
May/June 2016 (linear)		94%	45%	29%	21%	16%	13%	10%	8%	7%	6%	5%	4%	3%	2%	1%	1%	0%		
May/Jun 2016 (polymetric)		99%	49%	32%	23%	17%	13%	10%	8%	6%	4%	2%	0%							

Published in Algal Research: Bak et al. (2018) "Production method and cost of commercial-scale offshore cultivation of kelp in the Faroe Islands using multiple partial harvesting"

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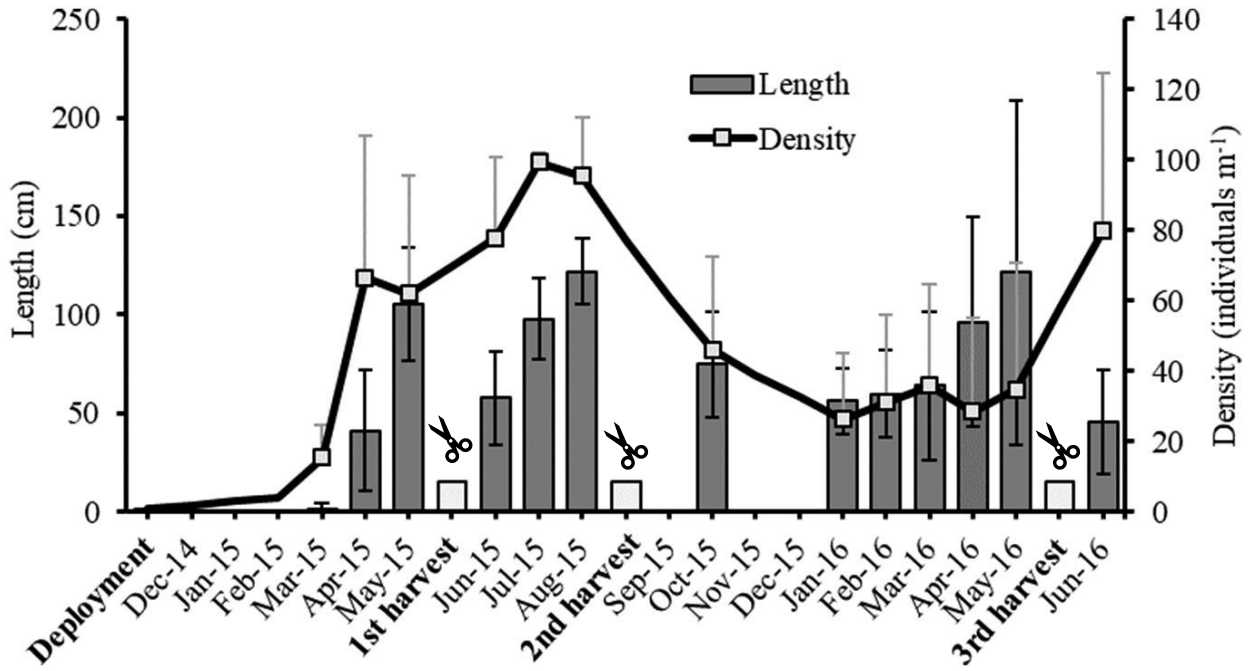
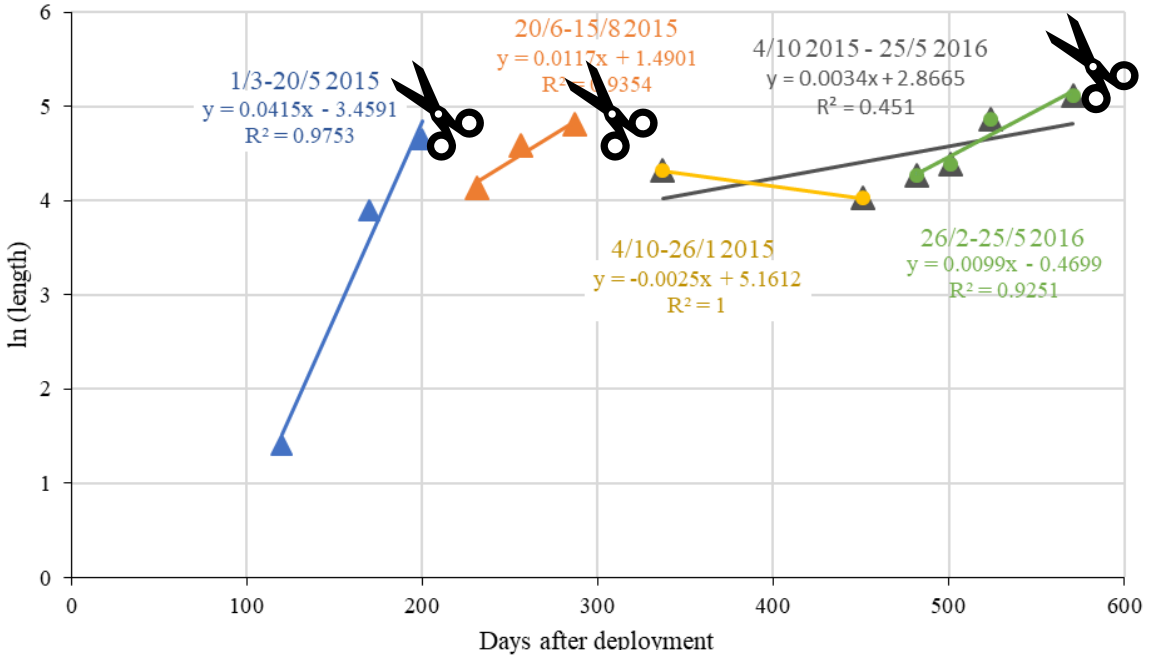
Seasonal variation of length and growth rate

Saccharina latissima, exposed site





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Multiple partial harvesting

November 2014
Deployment

May 2015
1st harvest
Yield: 3 tonnes FW

2.9 kg/m

August 2015
2nd harvest
Yield: 12 tonnes FW

4.1 kg/m

May 2016
3rd harvest
Yield: 13 tonnes FW

4.6 kg/m

August 2016
4th harvest
Yield: 7 tonnes FW

2.4 kg/m

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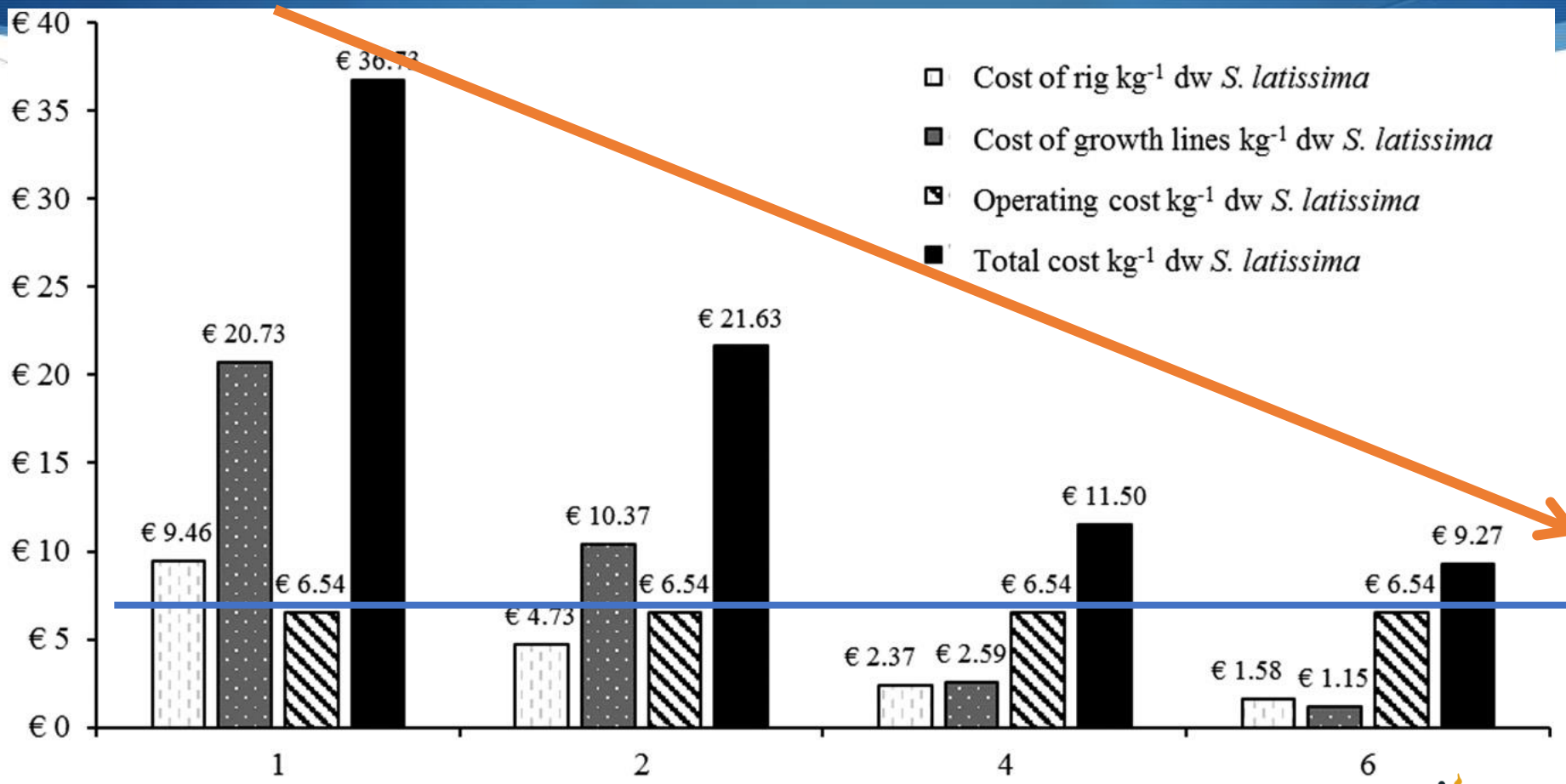
Cost reduction



Total cost

Operational cost

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Optimised handling to lower operational cost

Todays handling time at sea:

- **Direct seeding** of 5 km growth line, 4 persons = 5 hours
- **Deployment** of 5 km growth lines, 5 persons = 6.5 hours
- **Harvesting** of 40 lines, 500 kg ww, 3 persons = 3 hours, **4 minutes per line**
- Mechanical harvesting

being tested:

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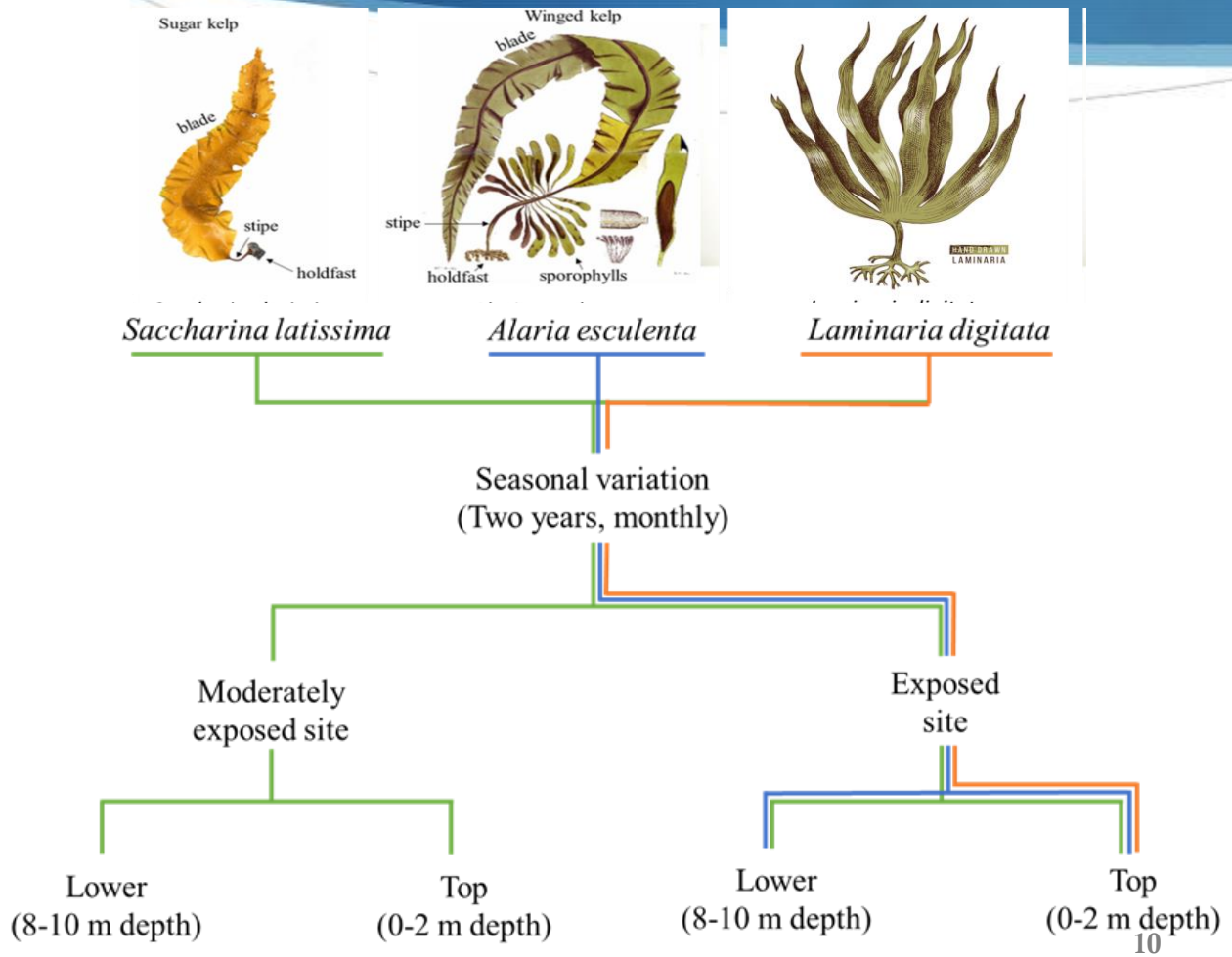
The biochemical composition



Water (dry matter)
Minerals (ash)

All institutes

Iodine
Inorganic arsenic
Nitrogen
Amino acid composition
D-vitamin + α- and β-carotene

DTU Food National Food Institute

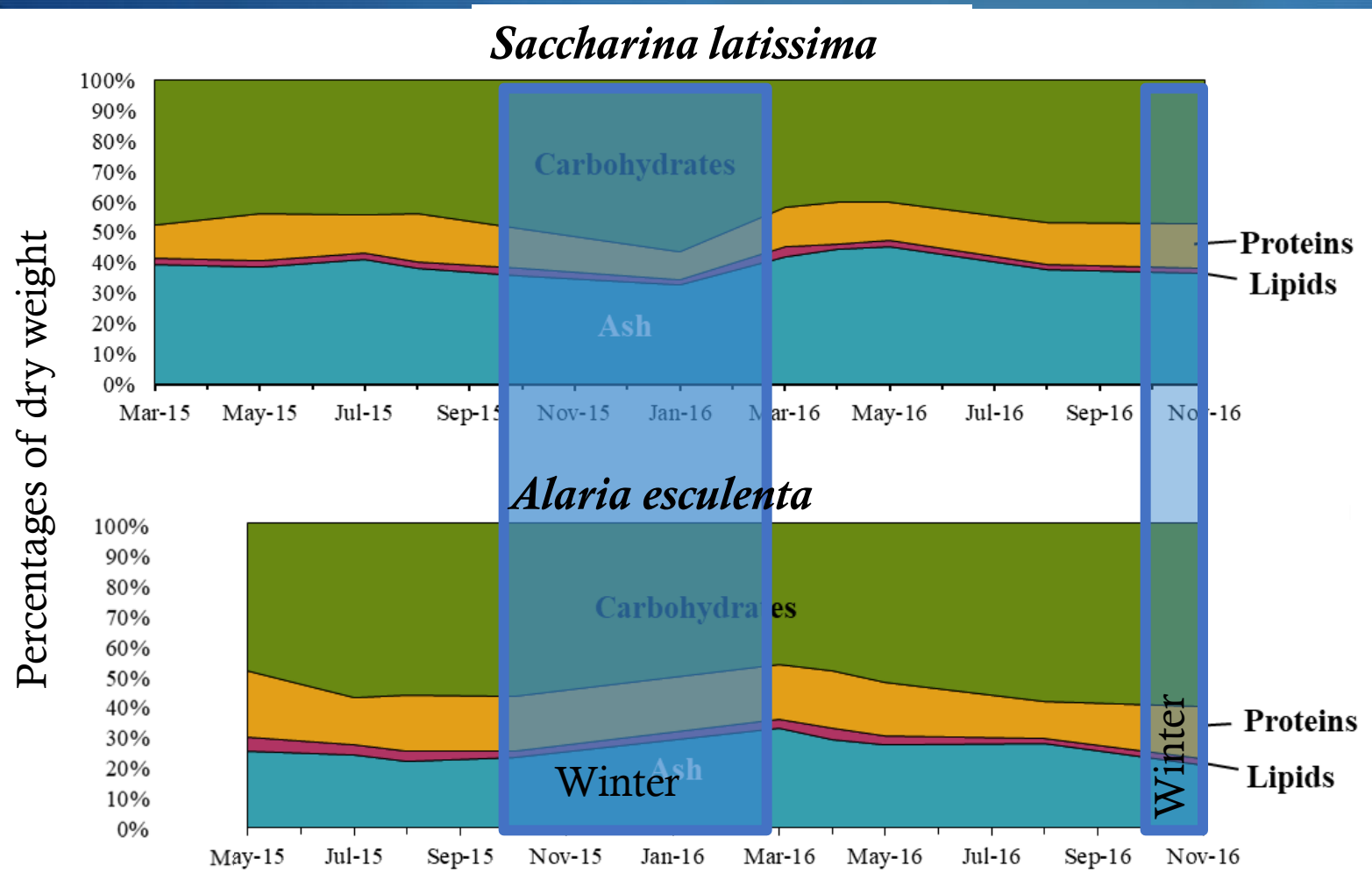
Mercury
Lead
Cadmium
Arsenic
Sodium
Protein
Lipid
Fatty acid composition
Carbohydrates (calculated)
Monosaccharides
Antioxidants

matís

Phosphorus
Carbon

AARHUS UNIVERSITET

Seasonal variation and product documentation



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The seasonal variation in nitrogen, amino acid, protein and nitrogen-to-protein conversion factors of commercially cultivated Faroese *Saccharina latissima*

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ABSTRACT

The demands of new food sources are increasing with the increasing human population. Proteins are a ma nutrient for human consumption and in animal feed, which will be in short supply in the near future. Ma macroalgal species have shown to possess significant levels and quality of protein, comparable to conventio protein-rich foods. The brown macroalga *Saccharina latissima* was commercially cultivated in an open ocean ar in the Faroe Islands. The effect of depth, cultivation site and seasonal variation in nitrogen, protein co centration, and the amino acid profile were investigated to study the potential of Faroese cultivated *S. latissi* as a protein source. Moreover, the nitrogen-to-protein conversion factor was calculated. The average nitrog concentration was 2.1 ± 0.2% of dry weight (dw) with no significant variation between sites, a single mor with significant variation between cultivation depths (March 2016), and a significant seasonal variation (amo most months). The average protein concentration determined by summing up total amino acids was 4.3 ± 0.5 of dw, and comparable to or slightly lower than other studies. There was no depth, site or seasonal variation AA-protein concentration for the cultivated *S. latissima*. The lack of seasonal variation was most likely a co sequence of the year-round stable physical conditions in the Faroe Islands, and compared with other studi surprising as most found seasonal variation of AA-protein. The quality of the protein was high (EAA score 100%) in March, although the low total concentration of protein limits the possibilities to use *S. latissima* sole as a protein source or for protein extraction and other nutrients should be investigated to understand its potent

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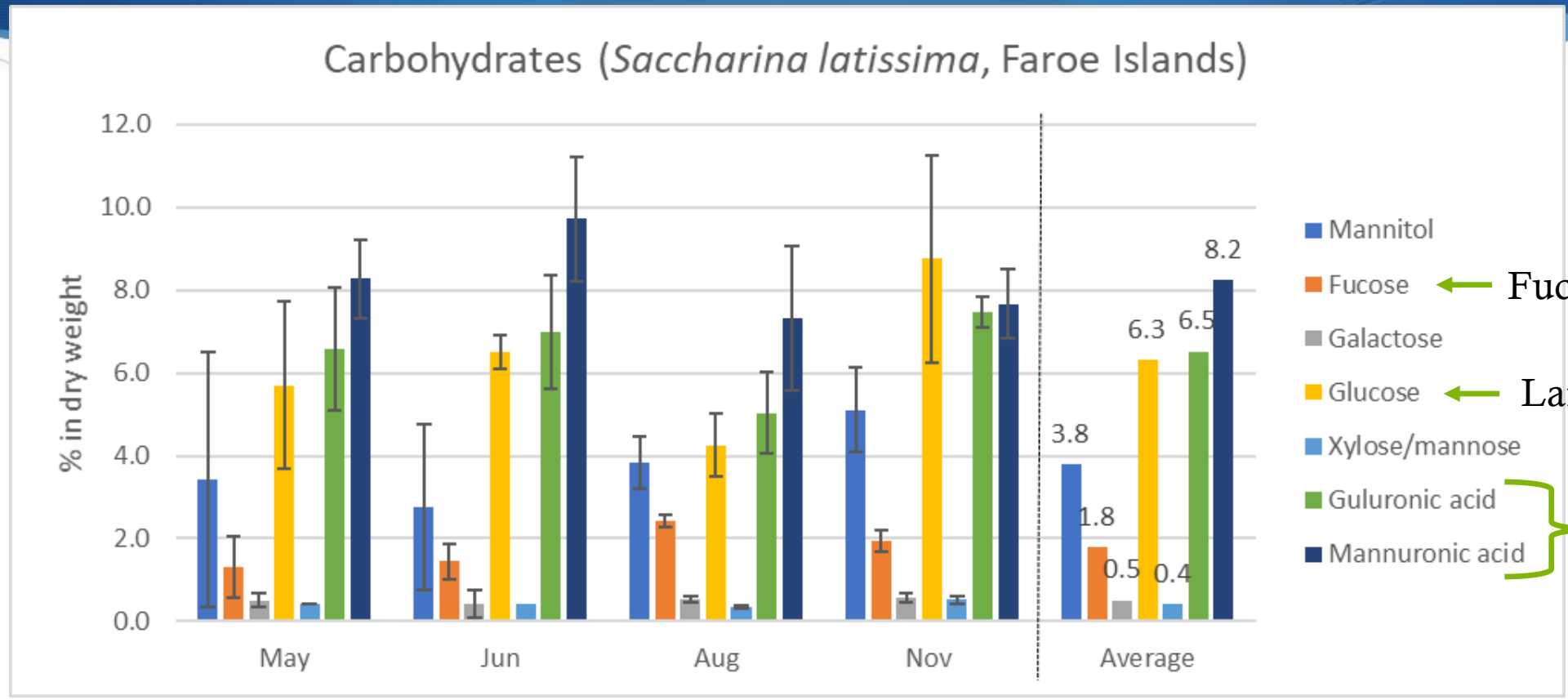
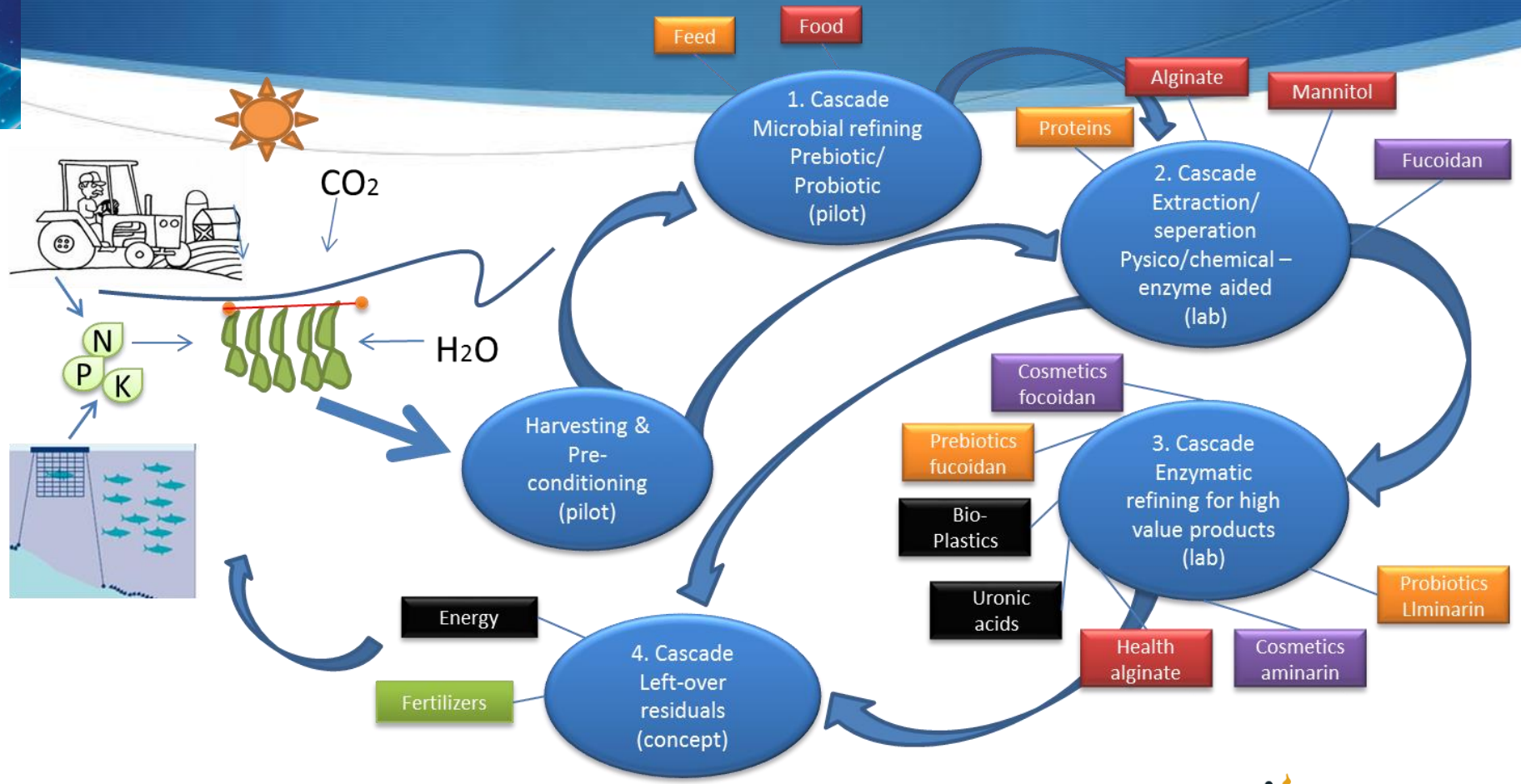
Heavy metals

	Analysed levels (mg/kg dw)	Recommended maximal level (mg/kg dw)	Reference
Arsenic	35-70	40	Recommended in feed (Commission Regulation - EU)
Inorganic arsenic	<0.3	3	Recommended in food (n/a for macroalgae) (Almela et al. 2002)
Mercury	<0.06	3	Recommended in whole fish (n/a for macroalgae) (Commission Regulation - EU)
Lead	<0.5	3	Recommended in whole fish (n/a for macroalgae) (Commission Regulation - EU)
Cadmium	1-2	3	Recommended in food (n/a for macroalgae) (Commission Regulation - EU)

Carbohydrates



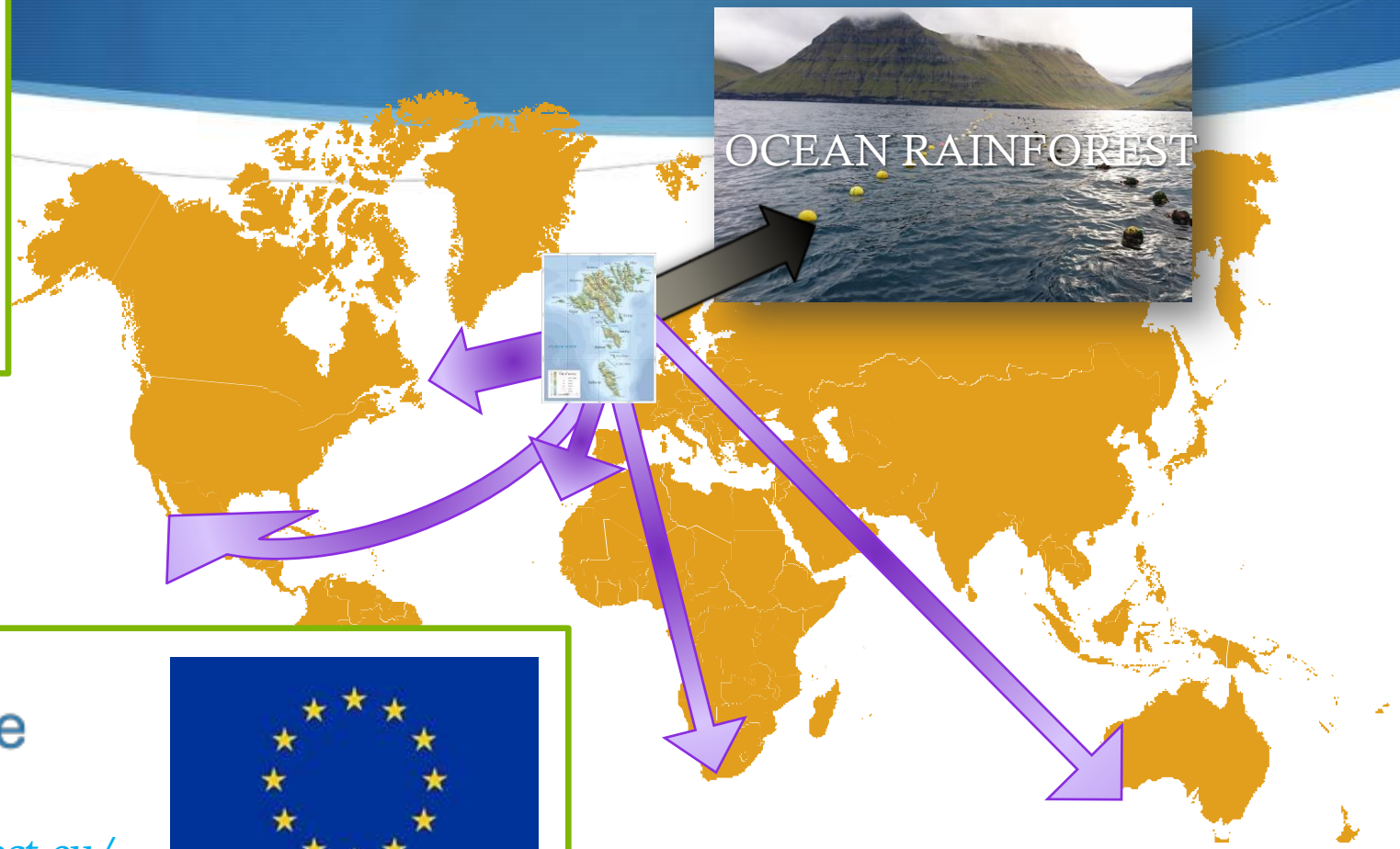
MacroCascade – the biorefinery concept



Knowledge transfer

arpa·e
CHANGING WHAT'S POSSIBLE

MACRO SYSTEMS



AquaVitae

https://aquavitaeproject.eu/

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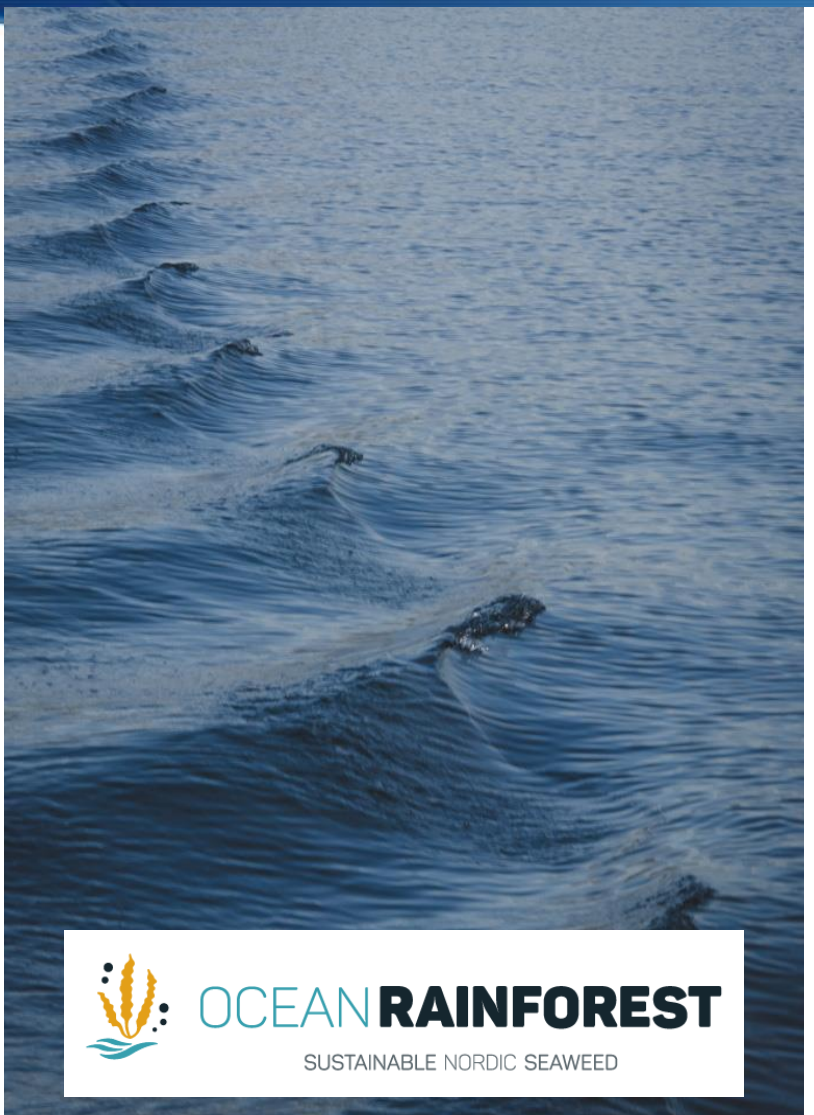
Take home messages



- Detailed knowledge of the seasonal growth pattern, harvesting yield and the biochemical composition provides a **predictable** production
- Multiple partial harvesting, direct seeding and mechanical harvest reduce cost of cultivation and helps to make the economy **profitable** to enabling return of investments
- Product documentation is crucial for innovation of future product applications and for biorefinery planning
- Knowledge transfer enables **upscaling** of the seaweed industry in the world